AVIATION

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CONTENTS FOR JULY, 1944

Volume 43 • Number 7

Briefing for July 5

Down the Years in Aviation's Log 5

Editorial: The Invasion Spotlighted Our Need: To Stay Armed .. 109

Boeing B-29 "Superfortress" ..... *Herb Powell* 110

Quality Plus Quantity Made D-day Possible 111

The Blitzkrieg Goes to Sea ..... *Vice Adm. John S. McCain* 112

How Women Flyers Fight Russia's Air War ..... *Madelin Blitzstein* 116

Here Are Your Markets, III ..... *John Foster, Jr.* 113

Aviation Research—Engineering—Production

Design Analysis No. 7, The North American P-51 *Mustang* ..... *William R. Nelson* 127

Fan Cooling "Ups" Engine Performance ..... *Kenneth Campbell* 148

Tooling Dock Technique Saves Time, Speeds Accuracy, I ..... *Leland A. Bryant* 152

So You're Going To Pressurize? ..... *Charles W. Morris* 155

Hole Piercing Proves Faster—And Cheaper ..... *Herbert Chase* 161

Load Characteristics of Cellulose Acetate Plastic, II ..... *William N. Findley* 164

Methods for Forming Sheet Aluminum, III 166

Electronics Smooth Supercharging 168

Aviation's Sketch Book of Design Detail 203

Aviation's Engineering Data Book 209

Review of Patents ..... *A. Harry Crowell* 212

New Products and Practices 242

Aviation Maintenance

How to Get Top Efficiency From Your Vacuum Pumps 171

Rebuilding the *Clippers* 175

Inspection and Top Overhaul on the Franklin ..... *F. B. Chadwick* 178

"On and Off" Speed is Aeroprop Feature 180

Service Steps for the Eisemann Magneto ..... *E. J. Goggins* 183

Aviation's Maintenance Notebook 185

Air Transport

Three International Policies—Which Will We Have? ..... *A. A. Hartsinck* 190

Civil Operations and Training

Contracts With Minors Can Boomerang ..... *Leslie Childs* 192

Southwest Airways Flies 1,000,000 Training Hours 195

Finance

Industry's Sales Soar . . . But Not Profits ..... *Raymond L. Hoadley* 197

Flying Equipment

New Auxiliary Engine Gives More Power-Per-Pound 199

Book Reviews 210

Side Slips 235

The Aviation News

National Aviation 213
War Communique No. 31 217
Washington Windsock 219
Aviation Manufacturing 221
Transport Aviation 225
Aviation Abroad 228
Financial Notes 231
Aviation People 233

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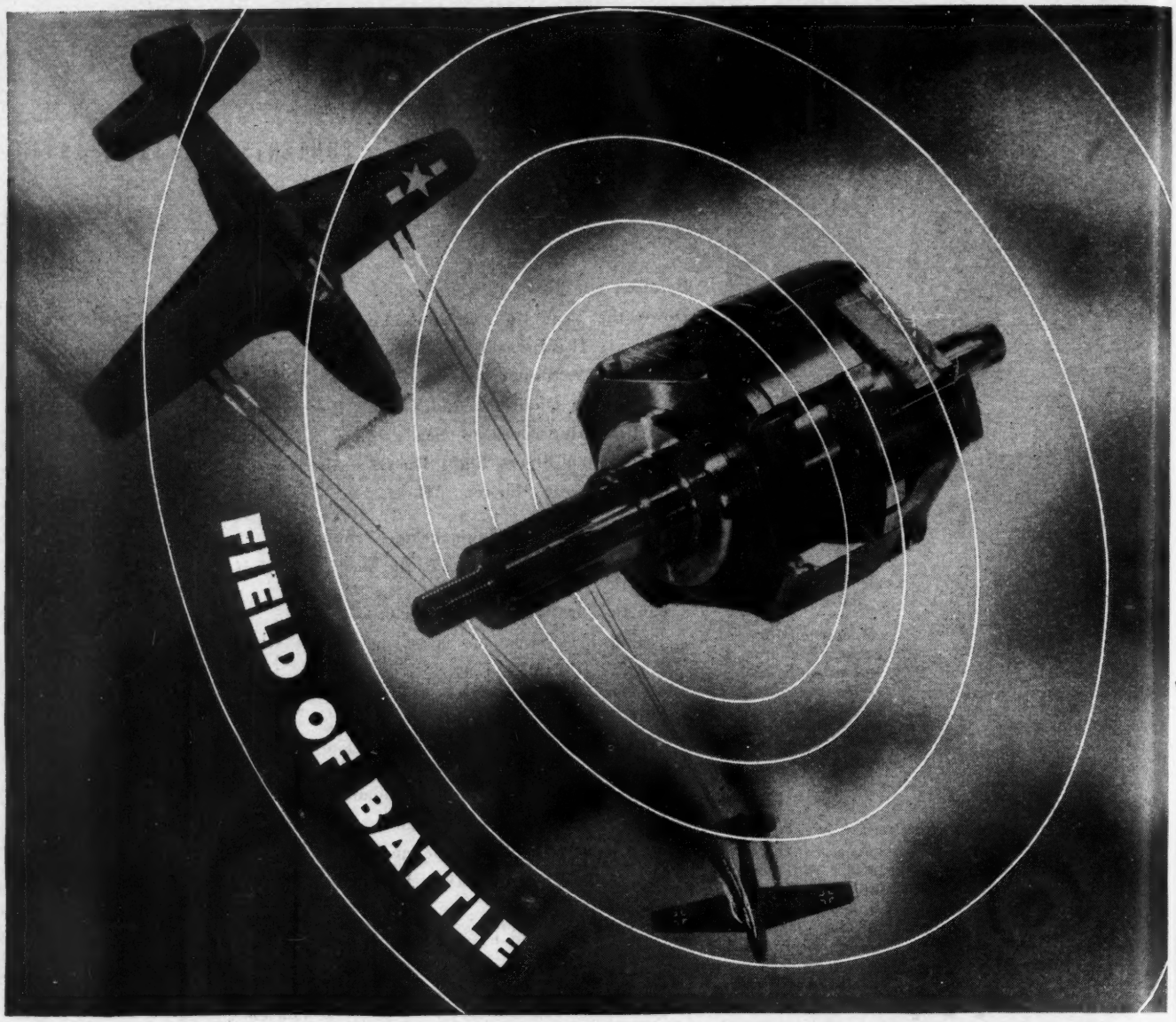

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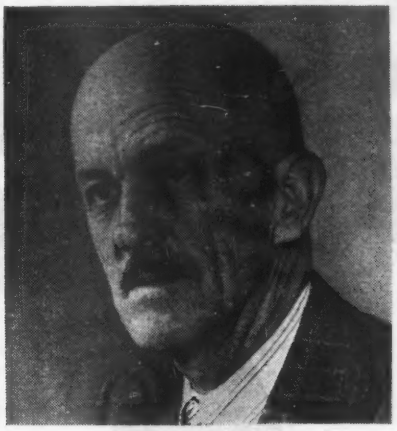
Briefing for July



KENNETH CAMPBELL (left), Wright Aero Senior Project Engineer, gives full details—backed up with our Aviation sketches—of the development of aircraft engine fan cooling (page 148). And LELAND M. BRYANT (right), presents the know-how for assembling and checking jigs and fixtures through an exposition of the tool dock he developed for Convair at San Diego (page 152).

If anyone ever doubts that "the best defense is a good offense," refer him to Vice Adm. John McCain's story on page 112. Here's the develop-ent of Jap-whipping strategy and tactics by our carrier-based aviation that actually converted liabilities into assets. And the look-see Adm. McCain gives us as to what's going to happen makes even better reading.

A lot of Nazi pilots wish that Joe Stalin believed the old adage that "woman's place is in the home." For, if Joe believed that, Goering's "supermen" wouldn't face the embarrassing prospect of being shot out of the sky by the so-called weaker sex. How Russian women fought for a place in the Red Air Force as combat pilots so they could battle Goering's boys is told dramatically in the story beginning on page 116.

Read anyone's list of "best" airplanes and you'll find the North American P-51 *Mustang* right up in the top flight. You'll understand why when you read the story on page 127—No. 7 in our unmatched Design Analysis series—a bang-up job by AVIATION's West Coast Editor Bill Nelson.

Here Are Your Markets —right on a two-page map which you can cut out and mark up to your heart's content (page 118). This month we conclude Managing Editor John Foster's important series, presenting the nationwide distribution framework. A reprint of the whole series is yours for the asking.

Pressurizing cabins for high altitude operation is really a two-way headache. For the Sales Department wants one thing—while Engineering wants to build something quite different. Charles W. Norris of AiResearch tackles the basic problems necessary to eliminate the headache (page 155).

Tomorrow's planes —pressurized or not —will mean bigger and tougher problems for maintenance men. Pan American's Atlantic Division is writing an invaluable handbook for these men as it replaces structural members in the faithful Boeing 314 *Clippers*. Details of this huge, completely pre-engineered task are given on page 175.

The personal flyer's and fixed base operator's maintenance field is covered, too. On page 178, for example, F. B. Chadwick, Aircooled Motors' Service Manager, gives all the dope on 10, 25, and 100-hr. inspections and top overhaul. Then, on page 183, E. J. Goggins gives the simple routine for keeping the new Eisemann 4- and 6-cylinder magnetos operating right up at 100 percent efficiency.

There'll come a day, sooner than many think, when the aviation companies' customer is going to change—from Mister Whiskers to Joe Public and Joe Junior. And if you're thinking of making contracts with a lot of Joe Juniors, for your balance sheet's sake read "Contracts with Minors Can Boomerang," by Leslie Childs. It's on page 192.

And speaking of profits (as who doesn't like to?) Financial Editor Ray Hoadley this month presents his annual exclusive roundup of the aircraft industry's financial standing. You'll find his table an excellent reference piece, and the survey itself is quite hopeful for the investor. Turn to page 199.

Before the great new Boeing B-29 *Superfortresses* blasted the Japs in their own front yards, Associate Editor Herb Powell had been to Wichita to study them —crawling from stem to stern and flying in one. In his first-hand story beginning on page 110, he tells you not only everything that can be told about the ship itself within the bounds of security, but gives the fascinating background information bound up with a truly great manufacturing achievement.

Down the Years in AVIATION'S Log

25 Yr. Ago (1919)—London *Daily Express* offers $50,000 prize for commercial flight to India and Africa carrying ton payload. . . . American Handley-Page Co. incorporated as airline operator at Ogdensburg, N. Y.

15 Yr. Ago (1929)—Frank Hawks flies twice across continent in 36 hr. 49 min. elapsed time. . . . TAT inaugurates 48-hr. coast-to-coast air-rail service. . . . Detroit-Chicago air service commences. . . . North American Aviation buys Pitcairn. . . . Bendix acquires Pioneer Instrument. . . . Amelia Earhart appointed ass't traffic mgr. of TAT. . . . Knott and Klingensberg of Germany open glider school at Cape Cod. . . . Phoebe Omlie of Memphis, Tenn., breaks women's altitude record at 25,400 ft. . . . Curtiss-Wright Corp. merger announced. . . . *Saturday Evening Post* buys Ford plane for business purposes.

10 Yr. Ago (1934)—Black - McKellar Act passed making temporary airmail contracts permanent. . . . Cleveland Airport handles 11,887 passengers in month. . . . USS aircraft carrier *Ranger* commissioned. . . . Naval Affairs Committee appropriates $5,363,000 for Pensacola Naval Air Station. . . . James R. Wedell killed while giving flight instruction. . . . Turkish Army sends six officers here to study aviation. . . . Richard C. duPont soars 155 mi. from Elmira, N. Y., to Somerset, N. J. . . . UAL orders de-icers for 30 Boeings from Goodrich. . . . DeHavilland obtains sole British Empire Mfg. rights for Hamilton Propellers, except for Canada. . . . Admiral Reeves, former *Langley* commander, becomes first pilot admiral. . . . Hisso produces 1,120-hp. 14-cyl. radial engine. . . . New England Lobster Co. buys Keystone *Commuter* to contact fishing fleet.

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THE INSTANT STARTING and reversal characteristics of the Kollsman Drag Cup Motor make it possible for this device to perform a vital function in the aircraft direction finder — keeping the loop antenna always pointing to the receiving station despite all movements of the airplane. Developed by Kollsman engineers specifically to meet the requirements of this unusual application, the Drag Cup Motor has been refined and modified to perform many other varied tasks. It is one of a new line of highly successful Kollsman miniature motors that give further evidence of the versatility of Kollsman precision engineering.

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Invasion Has Spotlighted Our Need: *TO STAY ARMED*

IN HIS CLASSIC WORK *On War,* Clausewitz, the father of German military strategy, describes the turning of the tide of battle as the "flashing sword of retribution". No words more eloquent could be found to herald the fast approaching twilight of the Nazi gods.

As the impact of invasion strikes the hearts of home-front workers, the purpose of their tireless efforts of the past three years becomes distinct. The piano manufacturers who fabricated strange pieces for countless gliders, the assemblers who dreamed of endless lines of C-47's, the builders of the *Thunderbolts, Mustangs,* and many other aircraft, now see the goal they have been striving for. Their objective has been more than victory. It has been victory at the lowest possible cost in lives.

It is too early to estimate the number of casualties spared by our surface forces as a direct result of relentless pre-invasion bombing plus the magnificent air support furnished by the 11,000 allied airplanes which took part in the invasion. But it is only necessary to glance back at our tragic losses in the first raid on Dieppe to evaluate the contribution of air power to the economy in expenditure of life in waging war. The elements of surprise and of initial superiority of force undoubtedly contributed. But without air power the results would have been appalling.

This is the humane side of aerial warfare. Terrible as air bombardment appears to any normal human being, it reduces the time and lives required to convince an enemy that he must yield to the conqueror's will.

OUR PRESENT OPERATIONS indicate that our military leaders have been quick to learn all the tricks that Herr Hitler taught. They have been able to add quite a few new ones and to perform all of them better and on a scale far beyond his fondest dreams. Behind our military might, industrial management and labor have demonstrated the overwhelming superiority of their efforts as compared with those of any or all of the enemy nations. But there is yet another lesson for our citizens and our statesmen to learn from Hitler before we return to peaceful ways of life. It is found in a single sentence on page 1 of *The Art of Modern Warfare,* by Col. Herman Foertsch, a brilliant strategist of the German General Staff. The translation carries out the typical Teutonic bluntness. It reads:

"To believe that it is only necessary to disarm oneself, in order to have others follow suit, is foolishness."

These words of wisdom are followed immediately by a quotation from the writings of the German Commander Moltke:

"Eternal peace is a dream and not even a good dream, for war is a part of God's world ordinance."

For those readers who might feel that this philosophy belongs to German thought alone, Col. Foertsch offers another direct quotation conveying the same idea from a great lover of peace—John Ruskin.

UNHAPPILY human progress has not reached the stage where war will disappear. Even the millennium is restricted to one thousand years. But if we cannot prevent wars we can and must strive to extend the time between future conflicts.

It is not mere coincidence that the attack on Pearl Harbor came as our aircraft production curve crossed that of the Axis powers. Enemy strategists knew full well that they must strike then, or not for a long time to come. History will show that they waited too long, underestimating our ability to accelerate production to unforseeable heights.

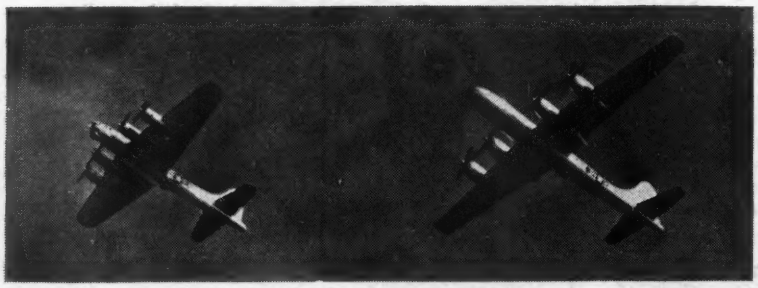
But from these obvious facts comes an uncomfortable but inescapable conclusion: If our airpower had been stronger, sooner, they would not have dared to attack us at all.

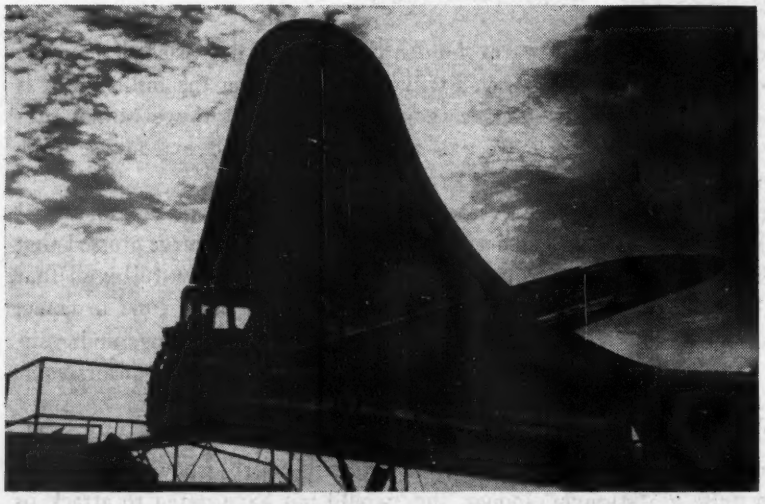
We have tried the disarmament route, and it has led us to the very brink of defeat. We must enhance our future security by turning the words of our enemies against them. No matter how eloquent the prattle of pacifists may seem, we must never relax in the preservation of our military might again.

Leslie E. Neville

EDITOR

BOEING B-29 "SUPERFORTRESS"



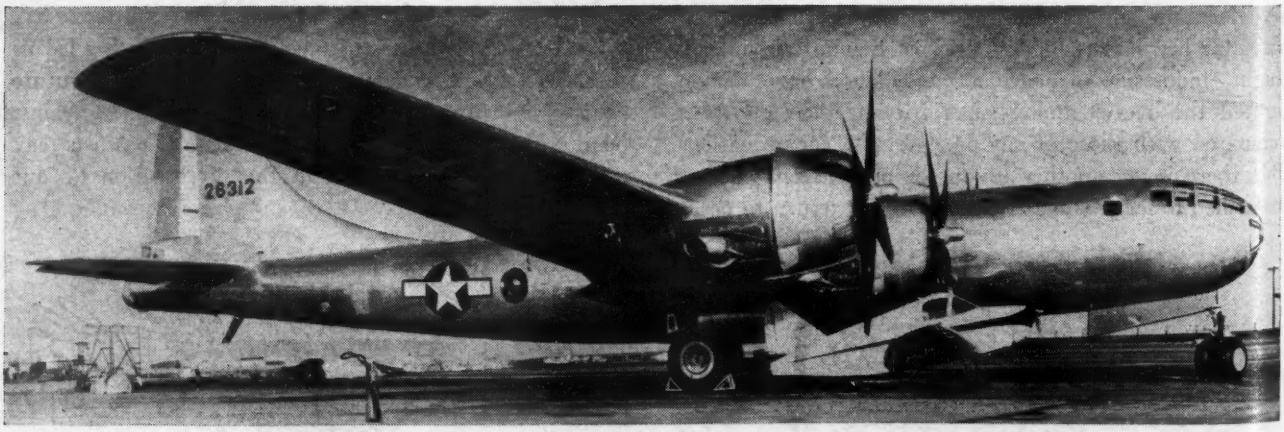


THESE B-29 SHOTS

graphically reveal structural and design details of Boeing's great bomber. Flight photo (top) indicates fine speed lines. This model has teardrop astrodome forward. Note Goodrich deicer boot installation on vertical stabilizer. Left: Flight photo of B-17G "Flying Fortress" alongside B-29 affords pointed comparisons; Latter, half again as large, has longer nose, and high aspect ratio of its wing is marked. Empennage view shows compact, multi-windowed tail-gunner's "office" (gun-bristling tailtip had not yet been fitted). Below: Sweeping lines of huge "Superfortress" are accentuated by sharp contrast with tiny Culver "Cadet." Seen is B-29's retractable tail-skid for protection of tail in landing. Side blisters of this ship have metal-grille covers. For security reasons, external armament is not shown in these photos.

Specifications and Performance

Span	141.2 ft.
Length	98 ft.
Height, at tail	27 ft.
Wing section	Boeing 117
Maximum chord	204 in.
Fuselage	Semi-monocoque, 9 ft. dia.; cabin pressurized
Landing gear	Tricycle (steerable, three sets dual wheels)
Armament	Multiple installations of 50-cal. guns in streamlined, low-protrusion power turrets; also a 20-mm. cannon.
Speed	Over 300 mph.
Ceiling	Well over 30,000 ft.
Power plants	Four 2,200 hp. Wright "Cyclones"



Biggest, Fastest, Highest Flying Bomber Carries Largest Bomb Load Greatest Range

By **HERB POWELL,** *Associate Editor, "Aviation"*

Pressurized cabin is feature of superbomber . . . Simplicity of plane's construction demonstrates maker's mastery of manufacture

TRIUMPH of putting the mightiest of bombers—Boeing's great B-29 *Superfortress*—into the air against our enemies is, above all, the triumph of the vision, ingenuity, effort, and courage of the American aircraft industry.

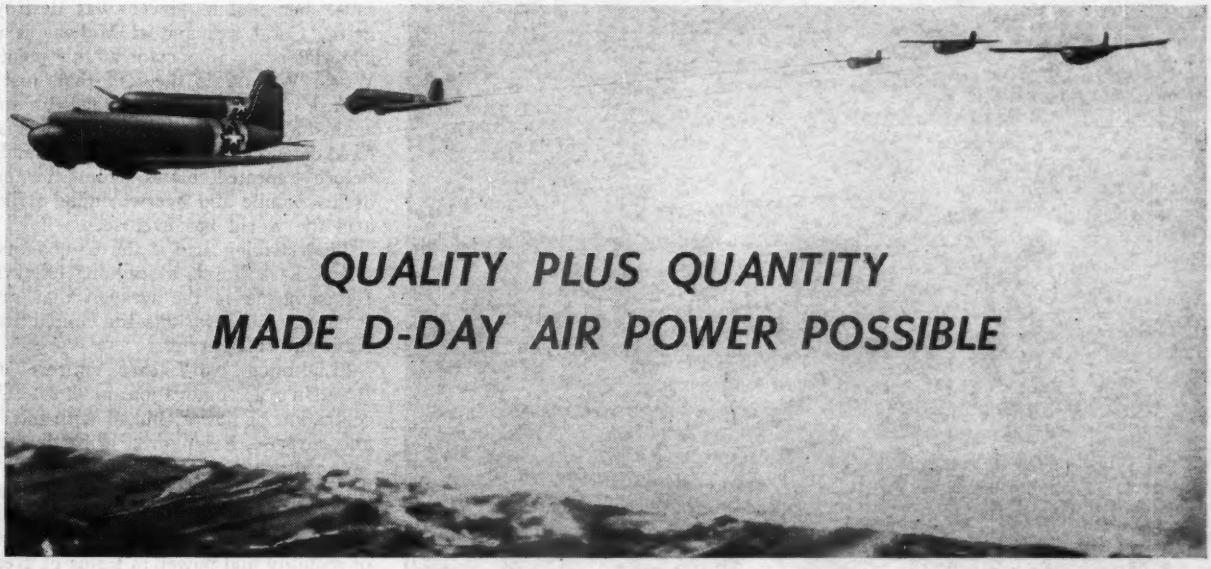
With the initial bombing of Japan by this most-powerful airplane, radio and press carried word to every man-in-the-street of this huge craft's tremendous capacities—for unequaled speed, range, bomb loads, and ceiling.

But it was the unequaled capacity of our industry which made it possible. That was the primary impression taken away by those of us who have observed the production lines in the Boeing Airplane Co. at Wichita and learned the detailed story of the superbomber from its makers.

Briefly, the B-29 (illustrated and also described in a table on the opposite page) is an all-metal, mid-wing monoplane with single-tail and retractable dual-wheel tricycle landing gear. Power, greater than that of any other bomber, is supplied by four, 18-cyl. Wright *Cyclone* engines of 2,200 hp. each, for a total of 8,800 hp. Through reduction gears these engines turn the largest propellers in use today, four-blade Hamilton Standard airscrews of 16 ft. 6 in. dia. Fitted to each engine are twin exhaust-driven turbosuperchargers, a dual installation necessitated by the fact that no single supercharger available was large enough for the high horsepower engines. Armor is built into the plane's fuselage, but it does not carry a load.

A prime feature of the B-29 is its pressurized cabin. Maintained via ducts leading from the superchargers on the two inboard engines, the pressurization is held fairly static to an initial high altitude, then falls slightly at subsequent higher altitudes with the increased rarity of the outside air. Oxygen masks are supplementary at extreme heights. Supercharging on one engine will supply the pressure, hence that on the other affords a 100 per cent reserve.

(*Turn to page 278*)



Greatest air operation ever undertaken featured Allies' long-awaited push onto European continent, and stellar role was taken by 9th Troop Carrier Command and its old reliables, the Douglas C-47's, which not only delivered paratroopers, but towed unnumbered Waco CG-4A gliders with airborne infantry and supplies to hold initiative for more than five hours before actual landings on shoreline. (Press Association photo.)

"Ten-tenths" air cover which featured great land-sea operation against Fortress Europe gives final proof of American manufacturers' formidable smash-the-Axis doctrine.

D-DAY WAS A DAY OF PROOF—bitter proof to the enemy—that our American aircraft production concepts were right.

It was a day of culmination for those who designed and built quality, multiplied it into Axis-smashing quantity, and got it to the front—largely on its own wings—with all the maintenance ingredients to keep it punching at a victory-insuring pace. Only D-day could bring us the ultimate proof, and now that it has come and gone the veil can be partially lifted and more of the magnificent record written.

Outstanding affirmative answer given was on the value and importance of airborne operations, with the 9th Troop Carrier Command emerging in a stellar role. Hitler, once the teacher,

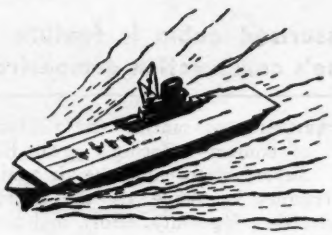
(*Turn to page 277*)

THE BLITZKRIEG GOES TO SEA

By VICE ADM. JOHN S. McCAIN, USN

Deputy Chief of Naval Operations for Air

Here, by one of the leaders who helped build it, is a dramatic yet realistic appraisal of our newest weapon—carrier-based aviation. What it can be expected to do in the future makes "must" reading.



"LIGHTNING WAR!" screamed headlines in 1939 as Germany unveiled the fastest, most completely mobile army of history. "Blitzkrieg" crashed into the world's vocabulary.

The catch-phrase captured public fancy, but significance of Nazi tactics apparently was ignored. France continued with what the world now knows was a dismal military mistake. She prepared to combat shifting, flexible, mobile power with a supposedly impregnable Maginot line of fixed fortresses—a line which possessed neither the length to prevent flanking nor the depth to forestall encirclement. Wehrmacht "Lightning" turned the Maginot line in 1940 and crushed the resistance of a mighty nation in 30 days.

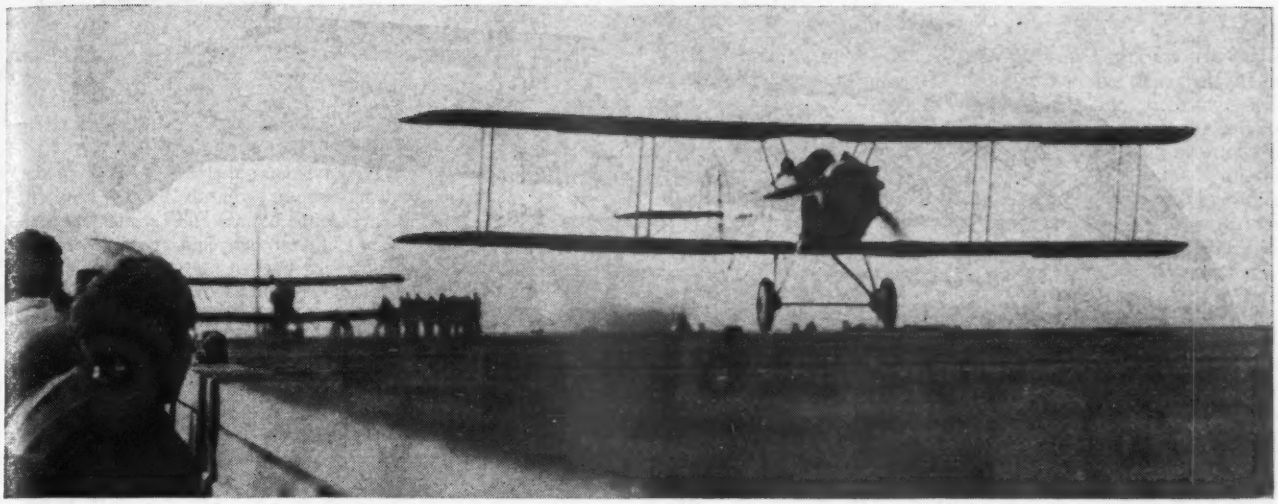
Japan, as Capt. Michael H. Kernodle* recently pointed out in addressing a Washington meeting of the Military Order of the World War, made the same mistake. Just as the French in 1939-40 pinned their defense to a chain of fixed fortresses, so the Japanese in 1942–43 tied their hopes to a "Maginot line" of bases in the Pacific Ocean. They placed themselves on the defensive in a fixed position, sacrificing their only chance to take the offensive and bid for a victory. That Japan was forced to rely on the stationary line because her mobile power was destroyed in the Coral Sea and at Midway is immaterial now. Important at this point in World War II is the fact that, just as France's Maginot Line failed to stand against a mobile enemy in 1940, so Japan's fixed defenses in the Pacific are crumbling before repeated blows from the most highly mobile and overwhelming striking arm the world has ever seen.

That striking arm is the United States Naval Task Force, a seagoing blitzkrieg. Its backbone is the weapon that saved America from invasion—the United States Navy aircraft carrier.

"Lightning war" isn't entirely new. It wasn't an innovation in 1939. Concentration of power, linked with mobility and surprise, has figured in battle tactics for centuries. Probably Hannibal and his elephants were waging "lightning war" when they crossed the Alps. Germany simply interpreted the combination of mobility and power in terms of greater speed, greater surprise, and greater re-

As Deputy Chief of Naval Operations for Air, Vice Adm. John S. McCain has been a vital factor in taking lightning war to sea via the aircraft carrier, and deeper and deeper into the enemy's territory. (Official U. S. Navy photo.)

* Capt. Kernodle was Air Officer aboard the *Wasp* when that carrier relieved Malta early in the war and Executive Officer when this carrier supplied air coverage for the invasion of the Solomon Islands. After the sinking of the *Wasp*, Capt. Kernodle was assigned to the staff of Gen. Vandergrift, Marine commander on Guadalcanal, with additional duty as commander of the Advanced Naval Air Base there.



Much of the success of today's carrier-task force operations is due to Navy tradition of always taking the offensive, plus foresight, as exemplified by this photo of early American carrier development, showing takeoff from the first real carrier, the Langley.

sulting devastation than ever had been attempted before.

It remained for the United States Navy and its aircraft carriers to lift this modern "lightning war" from its wheels and fixed airports; to develop the principle of concentrated mobile power into a truly worldwide striking force, unhampered by terrain, unfettered by coastlines. Aboard carriers, "lightning war" went to sea.

Many military experts are not fully aware, even yet, of the tremendous striking power of the individual aircraft carrier. The limits of the effective power which may be available when carriers are used in greater and greater numbers only can be imagined now. One newspaper correspondent hinted at it recently when he wrote:

"The United States Navy today can duplciate from the decks of carriers—in numbers of planes, at least—the 'thousand-plane raids' that caused so much excitement in Europe a few months ago. And to do this over Jap targets the Navy need concentrate only about half of its 'announced' carrier strength".

Can you imagine being able to place 20, 50, or even 100 airports, complete with runways, hangars, repair shops, and warplanes, within range of any single Japanese fortress we choose? Compared with this type of battle magic, the wizardry of Aladdin's genii was a shoestring operation. How many of the Japs' so-called "non-sinkable basis" do you suppose they can move into the battle area to combat such a force? The answer is none, no more than France could move its Maginot line fortresses to meet Germany's mobile attacks.

Candidly, we may as well confess that necessity fathered the tactics which developed the aircraft carrier into the commanding weapon of World War II. The mobile task force might never have evolved, despite that necessity, had the United States Navy not been steeped in the tradition that the best defense is a vigorous offense. And had it not been for earlier foresight, determination, and unswerving belief in Naval Aviation, the required striking power and superior mobility might never have been available when the necessity for such task forces arose from the ashes at Pearl Harbor.

Japan's attack on Dec. 7, 1941, was political treachery, but it was also a great military victory which left the United States facing the most difficult situation ever encountered by a naval power. With a Pacific battle line of four major combat units against Japan's twelve, the Navy was expected to stop the enemy advance, to save Australia and the Hawaiian Islands, and to maintain the extended supply lines to Sydney.

In addition to superior battle line strength, Japan had greater numbers of aircraft available for action. Its communication lines were shorter. Its convoy routes likewise were shorter and were protected. And it held the initiative. The once-powerful United States Navy was in a desperate defensive position with its battle-line strength so curtailed that any attempt to risk a fleet engagement would have been brazen foolhardiness bordering on national suicide.

The Navy might have defended the United States by blocking harbor entrances and waiting for Japanese forces to show up and start shooting, but at best such a course, completely foreign to the sound United States naval doctrine of aggressiveness, could scarcely have achieved more than a compromise or a stalemate—not victory. The Navy determined to meet the complex situation audaciously. From that determination sprang "lightning war" on the high seas.

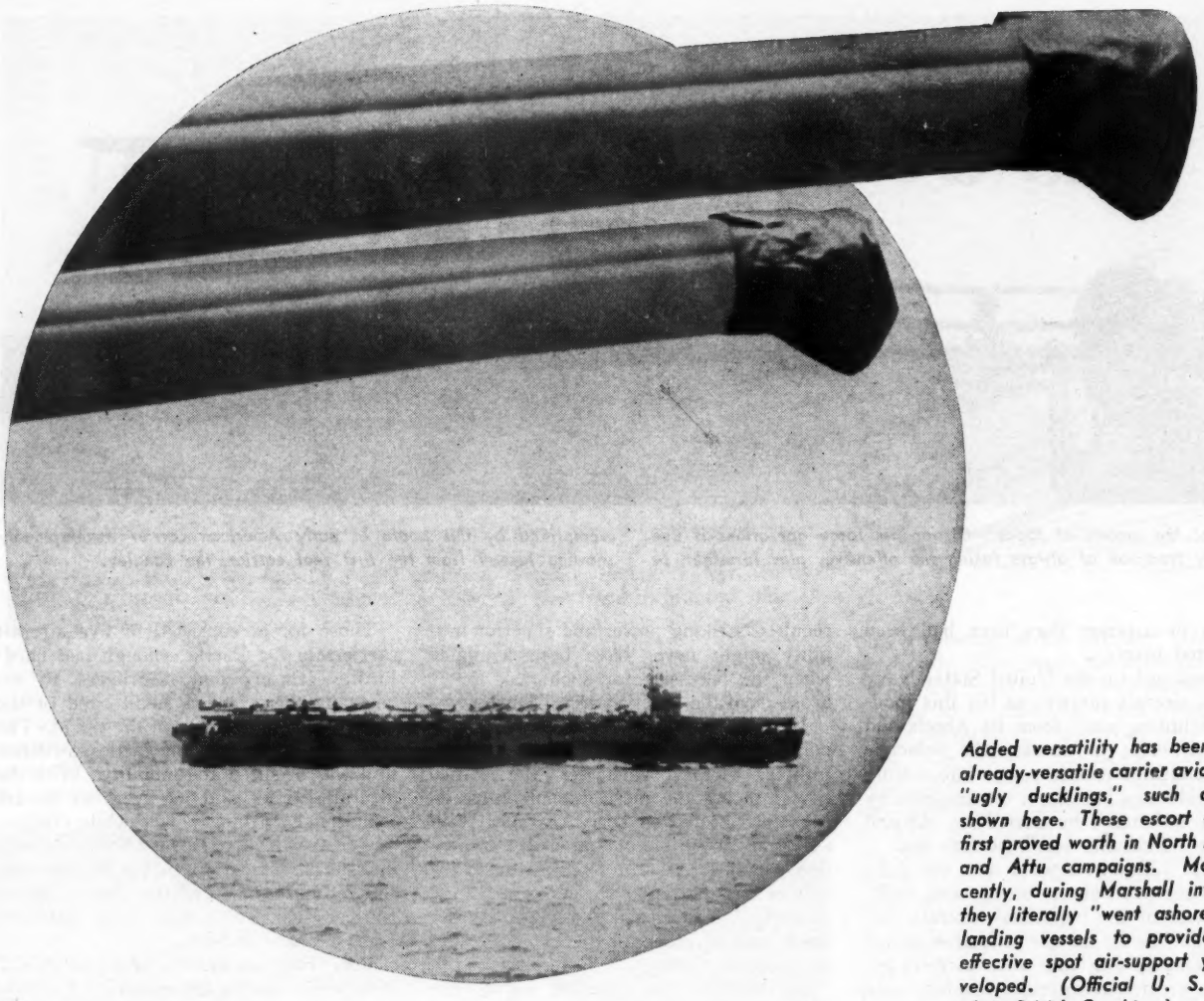
Strategically the Navy was forced to remain on the defensive until the European situation had been stabilized and until its Pacific strength had been regained, but that did not necessarily require a tactical defense. "The law and tradition of the United States Navy," its officers learn, "is to take the initiative and strike." Schooled in that tradition, the Navy had no alternative. Although strategically in a defensive position, the Navy doctrine called for tactical offensive with the forces that remained.

Those forces consisted of five aircraft carriers in the Pacific, enough fast hard-hitting cruisers and destroyers to accompany them, and a small band of the most competent airmen in the world. The Navy shelved battle line tactics, switched to a war of speed and mobility. With the aircraft carrier and its flyers to furnish long range striking power while cruisers and destroyers provided a defensive screen and short range strength, the flexible, mobile, almost independent United States Carrier Task Force took shape, fashioned to strike hard and fast.

Less than two months later, on Feb. 1, 1942, while daring air squadrons from the carrier *Enterprise* blasted Japanese bases at Roi, Kwajalein, Taroa, and Wotje in the Marshall Islands, equally daring airmen from the *Yorktown* struck Jaluit, Makin, and Mili in the Gilberts. Twin task-force thrusts smashed carefully constructed threats to American supply lines. The seagoing blitzkrieg was born.

These earlier carrier task forces were small, usually including only one, or perhaps two, carriers with a few protecting cruisers and destroyers. They roved the Pacific, raking the Jap's installations at every cruicial point, blasting his supply lines, disrupting his reinforcement routes, knocking his plans and progress completely askew. They raided Wake, then Marcus. Airfields and seaplane bases which the Jap laboriously built and manned as so-called "unsinkable carriers" were decommissioned in whole or in part just as surely as though they had been ships at anchor in the Pacific lagoons. The "unsinkable carriers" were the easiest sort of targets for the mobile United States carrier task forces—"sitting ducks," if you please. Uncle Sam's aircraft and big guns simply pounded them to ruins, then steamed majestically on their way to blast other installations.

Shattered along with those Jap installations were the remnants of the persistent theory that carrier aircraft were of value only as elevated platforms from which the enemy could be scouted and observed. Carrier planes demonstrated



Added versatility has been given already-versatile carrier aviation by "ugly ducklings," such as one shown here. These escort carriers first proved worth in North African and Attu campaigns. More recently, during Marshall invasions, they literally "went ashore" with landing vessels to provide most effective spot air-support yet developed. (Official U. S. Navy photo-British Combine.)

the striking power to stop the Jap; they became the Navy's Sunday punch.

The battles of the Coral Sea and Midway, in which destruction of her carrier strength doomed Japan's ocean mobility, further erased the battleline conception of naval tactics and clinched the carrier's place as backbone of the fleet. Opposing forces fought solely by means of air power without ever being within gun range of each other, or close to it.

As the battleship force regained its pre-Pearl Harbor strength, new and remodeled men-of-war joined the task forces, increasing the potency of each carrier by adding spectacular surface and anti-aircraft protection, bolstering task-force striking power by hammering Jap-held shore fortifications under umbrellas of friendly aircraft. Meanwhile, more and more aircraft carriers slid off the ways and joined the already potent mobile forces until task forces that included from 5 to 20 carriers and scores of supporting vessels dared the Jap to show his fighting fleet.

Early this year, the late Frank Knox, Secretary of the Navy, announced that more than 42 aircraft carriers of all types were in service. The launching of many, many more has been announced since that time. These range from the 33,000-ton fleet carriers, more than 800 ft. long and carrying more than 80 planes each, through the 10,000-ton converted carriers of the *Independence* class, down to the "ugly duckling" escort carriers. The last group, by sheer fury of attack in anti-submarine warfare and in the North African and Attu invasions, has earned an essential role in combat operations. The bold little escorts moved right in with amphibious forces in the recent Marshall Islands invasion to provide the most effective spot air-support yet developed.

As these various carriers joined the Pacific fleet, the rapier-like task forces developed into clubbing juggernauts that now rove hundreds of miles from the nearest friendly base and strike with impunity deep in enemy territory.

Consider the naval-air operations made possible by such forces as revealed during early February. The month opened with one gigantic carrier task force spearheading the conquest of the Marshall Islands, more than 500 mi. from the nearest friendly base. On Feb. 16 and 17, while many carrier planes still were helping the Marshall mop-up in the Kwajalein area, a carrier task force bombed and shelled Truk, one-time bastion of the Jap naval strength more than a thousand miles past Japan's "unsinkable carrier" front line. Meanwhile, another carrier task force attacked Eniwetok Atoll, leading an invasion which was completed Feb. 21. While that operation progressed, the Truk attacking force steamed northward to the Mariana Islands between Truk and the Japanese mainland where, on Feb. 22, its carrier-based planes pounded bases on Saipan and Tinian.

These were not just stabs. They were crushing blows. Japs based on the Marshalls and Eniwetok were beaten into submission and the territory occupied. At supposedly untouchable Truk at least 23 Japanese vessels were sunk and more than 200 aircraft downed. These operations included none of the naval activity farther south in the Pacific area nor any of the many supplementary forays by army and navy long range bombers. And the world thought it was seeing "lightning war" in 1939!

Despite present success, as task forces focus mighty military power at key points, the United States must continue to plan on the basis of a long war against resourceful and determined opponents. Under-estimating the enemy is a luxury that even a powerful nation such as ours can ill afford. No one can foretell now whether the United States still will be at war in late 1945 or 1946 when the new 45,000-ton super-carriers (for which contracts recently were announced) become

available, much less predict what effect they may have on naval operations.

It is difficult to imagine how super-carriers could enable United States forces to traverse wartime seas with any more security than is now being achieved. Present forces have dared Jap sea power again and again. The United States Naval Air Force, minus super-carriers, has without a single exception proved superior to any opposing aircraft, whether based on land or sea. The myth of carrier vulnerability to land-based air opposition already has been disproved. Super-carriers simply are expected to increase the United States Naval Air Force's present superiority. How much, no one now knows.

Greater armor protection and so-called super-decks should give super-carriers increased immunity to bomb damage. Greater compartmentation should nullify the torpedo threat. Wide flight decks and heavier arresting gear are expected to make routine the use of twin-engine bombers possible in regular carrier procedure, thus extending carrier aircraft range and adding to destructive fire power of task forces.

The net value of such improvements cannot be accurately determined on the basis of present enemy equipment and tactics. Recent bomb and torpedo attacks aimed at present United States carriers have been utter failures. At Rabaul, Japan lost 64 of 70 planes when it attempted such an attack. Carriers afloat today have proved that their compartmentation is adequate to permit them to take torpedoes and continue in combat. Present task forces are not finding the additional range and power of twin-engine aircraft necessary in order to shatter crucial bases of the Japanese defense system in surprise attacks.

However, having felt the devastating power of lightning war at sea, the nation's enemies undoubtedly are making every effort to adjust their defenses to meet it. By the time the super-carriers are ready for the fleet, it may be that their additional power, speed, and air range will be required. Construction of the super-carriers can best be termed insurance—insurance of continued victory in the Pacific—for they will mean increased carrier effectiveness, and victory in the Pacific most certainly hinges on the mobile warfare waged by aircraft carriers.

"Hinges" does not imply carrier self-sufficiency. The carrier alone is no more a self-sufficient combat unit than an isolated battleship; no more invulnerable, nor vulnerable, than any isolated advanced base. The fleet carrier is simply a mobile flying field which can stay at sea for weeks with its 2,000 or more officers and men and can fuel and supply other ships as well as its air complements. It has its own hangar, its own weather bureau, its own repair shops and replacements, but it still requires support. Tactically it oc-

(*Turn to page 257*)

Today, using less than half its "announced" carrier strength, U. S. Navy can throw thousand-plane raids from carrier decks against Japs' supposedly "unsinkable carriers"—string of fatally immobile land bases. Such raids, says Adm. McCain, can easily be dwarfed by action of our forthcoming super-carriers. (Official U. S. Navy photo.)

Celebrated Soviet women flyers—Marina Raskova (left), Paulina Ossipenko (center), and Valentina Grizodubova. Latter, now USSR's Chief of Aeronautical Authority, Foreign Division, is sole survivor of this record-breaking trio, for Maj. Raskova met death in air combat last year, while Capt. Ossipenko was killed while testing a new aircraft prior to the Nazi invasion. (Sovfoto.)

HOW WOMEN FLYERS FIGHT RUSSIA'S AIR WAR

By MADELIN BLITZSTEIN

Many hurdles—of education and of opportunity—have faced the women who have contended for places in Soviet aviation. But those places definitely have been won, first in record flights and now in actual front-line sky fighting.

DESPITE THE FACT that the Russian government officially discourages their participation in combat flying, many Soviet women have, nevertheless, joined the air fight against the Nazis. And they have rung up an outstanding record in shooting the enemy from the skies, as well as in bombing many key Nazi objectives—this in addition to their excellent job of essential flying behind the front.

The striking bravery and skill of Maj. Marina Raskova, pilot and Red Air Force Regiment Commander, is exemplary. Killed in air action last year, her ashes were laid, with full military honors, in the Kremlin wall not far from those of her co-flyer, Capt. Paulina Ossipenko, who met her death while testing a new plane some months before the Nazi invasion. The Raskova rites comprised the first state funeral held in the Soviet Union during the present war.

Today, other women pilots are constantly in training to take the place of those who, like Raskova and Ossipenko, fall in active duty.

Now holding the important USSR post of Chief of Aeronautical Authority, Foreign Division, is Valentina Grizodubova, sole survivor of the courageous Raskova-Ossipenko-Grizodubova trio. Valentina was awarded the coveted title of Hero of the Soviet Union because, together with her two comrade flyers, she made not only national but international aviation history.

While these three Russian women pilots established new records, both as individuals and in concert, it is the biography of Valentina Grizodubova which is most closely connected with the historical development of aviation in the Soviet Union.

Before the October Revolution, Valen-

tina's father, Stepan Grizodubov, an industrial scientist, evinced ability in both aircraft construction and flying. In 1910, he completed the design of his first aircraft—one of the initial Russian airplane designs. Like the Wrights, Grizodubov personally built the plane he had visualized, with certain aid from interested fellow workers. Meanwhile, not having a son, he saw nothing unusual about taking his daughter up into the air with him. Thus Valentina was introduced to the air at an early age.

It was in 1928 that Valentina received her pilot's license, but she was not yet satisfied with her knowledge of aeronautics. She continued her studies and, in a few years, was made an instructor in a flying school. Later, she was named pilot of the Gorky propaganda air squad.

By 1937, Pilot Grizodubova held no less than five international women's flying records. These were awarded for flying a single-seat sport plane 100 kilometers (63 mi.) at an average speed of 137 mph.; for flying a single-seat light seaplane the same distance at a speed of 118 mph.; for flying a two-place seaplane this distance at an average speed of 124 mph.; for bettering the current international altitude record for women by making a flight to a height of 1.98 mi.; and for breaking the non-stop flight record for women by flying from Moscow to Aktubinsk in Asiatic Russia, a distance of 901.5 mi.

For these and other achievements, Pilot Valentina received the Red Banner of Labor and the Order of the Red Star. Moreover, in December 1937 she was elected a deputy to the Supreme Soviet, for she was then—as she is now—interested in governmental matters.

In 1938 she joined hands with Marina Raskova and Paulina Ossipenko. Each of the latter had had an individual aviation history totally different from hers.

Once an air club instructor and engineer at Moscow's Frunze plant, Lt. Valeria Khamyakova is now a fighter pilot. She is credited with downing a Ju-88. (Sovfoto.)

Jr. Lt. Lilya Litvak was awarded Order of the Red Star following service at Stalingrad, where she accounted for three enemy planes in single-combat and helped down two in group-combat. In a later action, she was attacked by four Messerschmitts, and despite a serious leg wound she destroyed two of them and eluded the others. She was, however, killed at the Battle of Kharkov in 1943. (Sovfoto.)

Perhaps the most interesting life story is that of Paulina Ossipenko, born in 1907 in the Dniepropetrovsk Region. There were twelve children in Paulina's peasant household; her mother was illiterate and her father could read and write only with great difficulty.

When Paulina reached school age, her family was unable to buy her shoes, clothes, or books, hence school was ruled out; instead the little girl went into service, first as a nurse, then as a farmhand, and finally, at 17, she was working as a charwomen in a grain elevator.

When farm collectivization was introduced, Paulina got a chance to show her capabilities; she was shifted to work on a poultry run, and she served there long hours, with noteworthy conscientiousness. Due to her labors, the health of her poultry was exemplary, and as a reward the villagers elected Paulina Ossipenko to their local Soviet in 1927.

This office brought Paulina another opportunity to increase her knowledge; she went to the village school and studied grammar and mathematics. And soon she was transferred to the city of Kiev to delve into poultry science. It is to be noted that those days were doubly difficult for her because most of her fellow pupils had much more previous schooling than she. Paulina had to spend nights cramming her lessons, and she often had to have extra help from the other students. Nevertheless, she was graduated with honors and certified back to her native village as an instructor in poultry-raising.

Farm life filled this girl's time and thoughts—until one day two training planes visited the village. Immediately Paulina made up her mind to become a pilot. And in spite of the open derision from the local farmers—who were certain that a chicken raiser was not fit to be an airplane pilot—Paulina, after great insistence, gained permission to enroll in an aviation school near Sevastopol. The mysteries of physics, electrical engineering, and aerodynamics accordingly were unveiled for her, and Paulina Ossipenko was graduated in 1932 with exceptional grades. When she returned to her native village dressed in flying kit, her family was rightly proud and the villagers incredulous.

Because of the ability she had displayed, Paulina was sent to serve with the air unit of the Kharkov garrison. Only two years later, she was made a flight commander, her special field becoming altitude flights. She flew to a height of 4.7 mi. without oxygen, then broke all existing women's records for altitude flying by hitting the mark of 5.5 mi. In addition to these records, Paulina established (in three successive days, May 22–24, 1937) three international women's records: One for altitude without a payload, a second with half-ton payload, and the third with a one-ton payload.

Now ranked as a lieutenant, she was quickly to win additional honors: There came her election as a delegate to the All-Army Conference of Commanders' Wives in Moscow in 1936 . . . at the Kremlin, she delivered a speech concerning the participation of women in national defense . . . and the people's Commissar of Defense granted her permission to attempt a non-stop cross-continent flight from Sevastopol to Archangel.

In July of 1938, she completed this flight, with Vera Lomako and Marina Raskova as her co-pilots. For this success, Paulina Ossipenko was made a captain and awarded the Order of Lenin.

This Sevastopol-Archangel flight was Paulina's first with Marina Raskova. Let

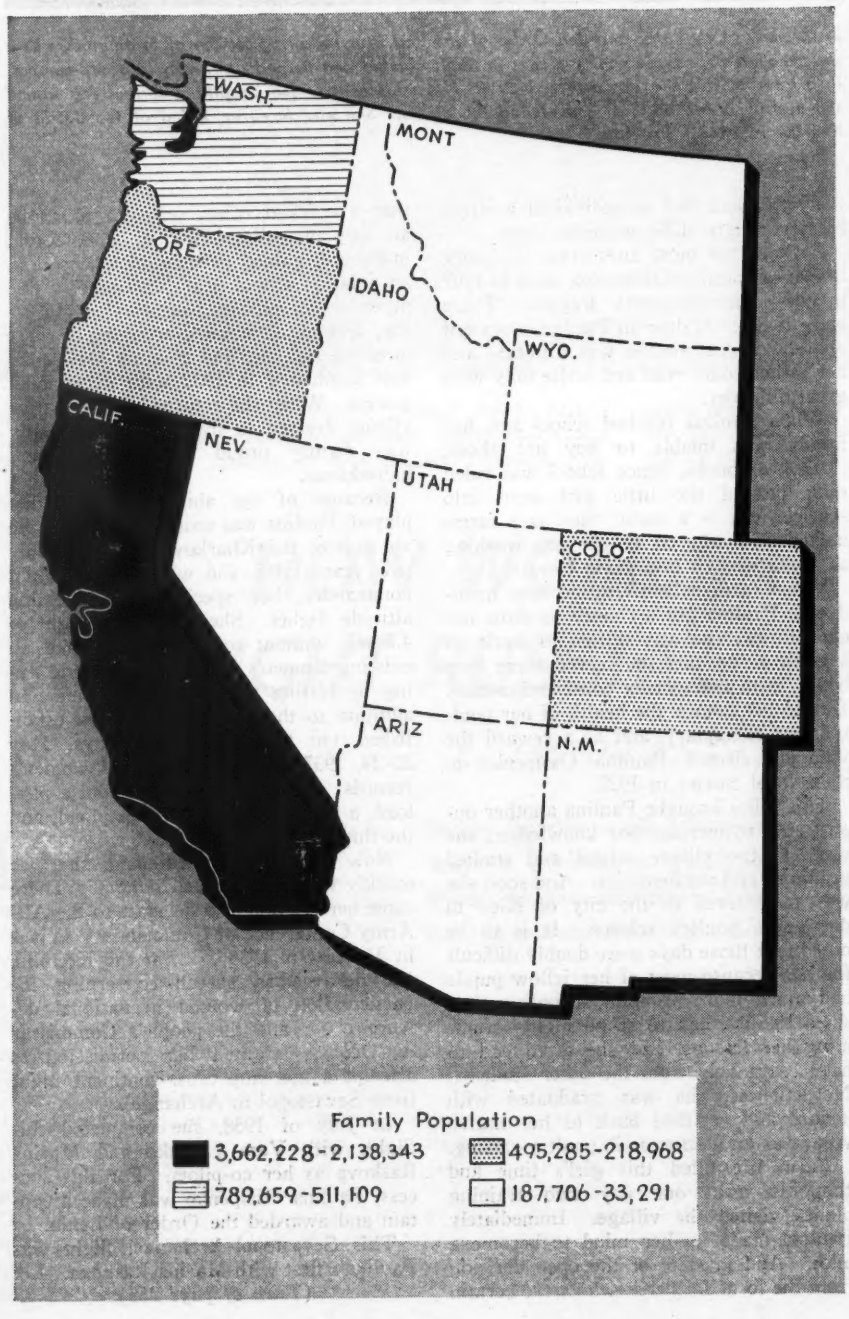
(*Turn of page* 255)

HERE ARE YOUR MARKETS

PART III — MOUNTAIN AND PACIFIC REGIONS AND CONCLUSION

By **JOHN FOSTER, JR.** *Managing Editor, "Aviation"*

Concluding AVIATION'S detailed presentation of nation-wide merchandising data, the Mountain and Pacific regions are analyzed. And finally, the broad distribution framework is ranged, with logical locations named for setting up a national aviation-product sales and service network.



COMPARED WITH THE "LUSH" MARKETS of the Middle Atlantic and Pacific regions, and the consistenly fertile fields provided by the East and West North Central areas, the eight states comprising the Mountain region at first appear to present formidable obstacles to aircraft sales and service. True, the distributors and dealers—like the cities themselves—will be farther apart, but there must be both sales and service in any complete distribution organization.

Although the Mountain region is eighth in importance among the nine regions, according to the measurable data shown in Table VIII, analysis of Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, and Nevada as individual states shows aircraft and accessory manufacturers can find profitable outlets for their products in the region.

Montana, with 159,963 families, has but 0.6 percent of the U. S. total, with .37 percent of the buying income and .42 percent of the retail sales. It should be noted, however, that the 129,758 passenger cars owned means that four out of every five families has this type of transportation. Pilots outnumber private planes by a bit over 7 to 1; for the last available date (as of Oct. 1, 1941) showed there were 786 non-airline pilots registered, compared with 163 planes, or 0.7 percent of the country's total. A total of 69 airports give the state .47 improved landing facilities for every 1,000 sq. mi. On a weighted basis, Montana measures out in 35th place among the 48 states.

Idaho's 141,727 family population is just 0.5 percent of the nation's total, and the state's buying income and retail sales percentages stand at .30 and .37, respectively. Here again, the automobile ownership is high, the total standing at 116,972, or 83 per hundred families. Here again, also, the pilots outnumber the planes owned by over 7 to 1, the figures being 748 and 106. The 42 airports—well distributed geographically—give the state .51 ports per 1,000 sq. mi. The combined factors put Idaho in 38th place among the states.

Conforming closely to the Mountain region pattern, Wyoming's 69,374 fami-

Sparse is word for family populations in eight states making up Mountain region, for Colorado is only one to top 300,000. Nation's smallest state-family population —33,291—is in Nevada. Nevertheless, complete network of aviation product distribution outlets will include Mountain region, and profitably so. Three Pacific states cover many ranges, with California measuring out as Class A market in this—as well as every other—category.

lies comprise but 0.2 percent of the nation's total, but automobile ownership continues at nearly one for every family—61,423. Buying income and retail sales stand at .17 and .21 percent of the national total, respectively.

Although the state is the home of famed Yellowstone National Park, little has been done to encourage flying in this unusual summer resort area, for the state has only 35 airports—.35 per 1,000 sq. mi. This lack of facilities may account for the fact that the state had but 471 non-airline pilots and recorded ownership of but 86 aircraft, factors which weigh the state at 44th place on a state-by-state rating.

In 31st place on a weighted state basis, Colorado is one of the five mountain region states in the Class D bracket. Family population of 316,000—largest in the region—is 1.2 percent of the national total; buying income is .71 percent and retail sales are .82. Typical of the region, though, is automobile ownership, the total standing at 279,849, an average of 89 for every hundred families. Registration of aircraft is also highest in the region, the 222 planes making up 0.9 percent of the national total. Pilots not engaged by airlines total 1,339, a ratio of more than 6 to 1. Airport facilities here, too, are hardly commensurate with the scenic attractions of the state, for with 47 ports, landing facilities measure out to .45 per 1,000 sq. mi.

New Mexico and Arizona appear to offer greater potentialities than actualities, for their family populations of 129,475 and 131,133 together make up only 0.7 percent of the national total, while buying incomes are .21 and .30 percent each and retail sales amount to .26 and .35 percent respectively. Automobile ownership, however, is greater in Arizona, the average standing at 79 per hundred families, compared with 62 in New Mexico.

In straight aviation criteria, too, Arizona leads its neighbor state, except for aircraft owned; New Mexico has 143 and Arizona 1 less. Pilots registered totaled 657 in Arizona and 542 in New Mexico, and in airports the Sunshine State again led, 70 to 60. Individual state ratings put Arizona in 36th place, New Mexico in 37th.

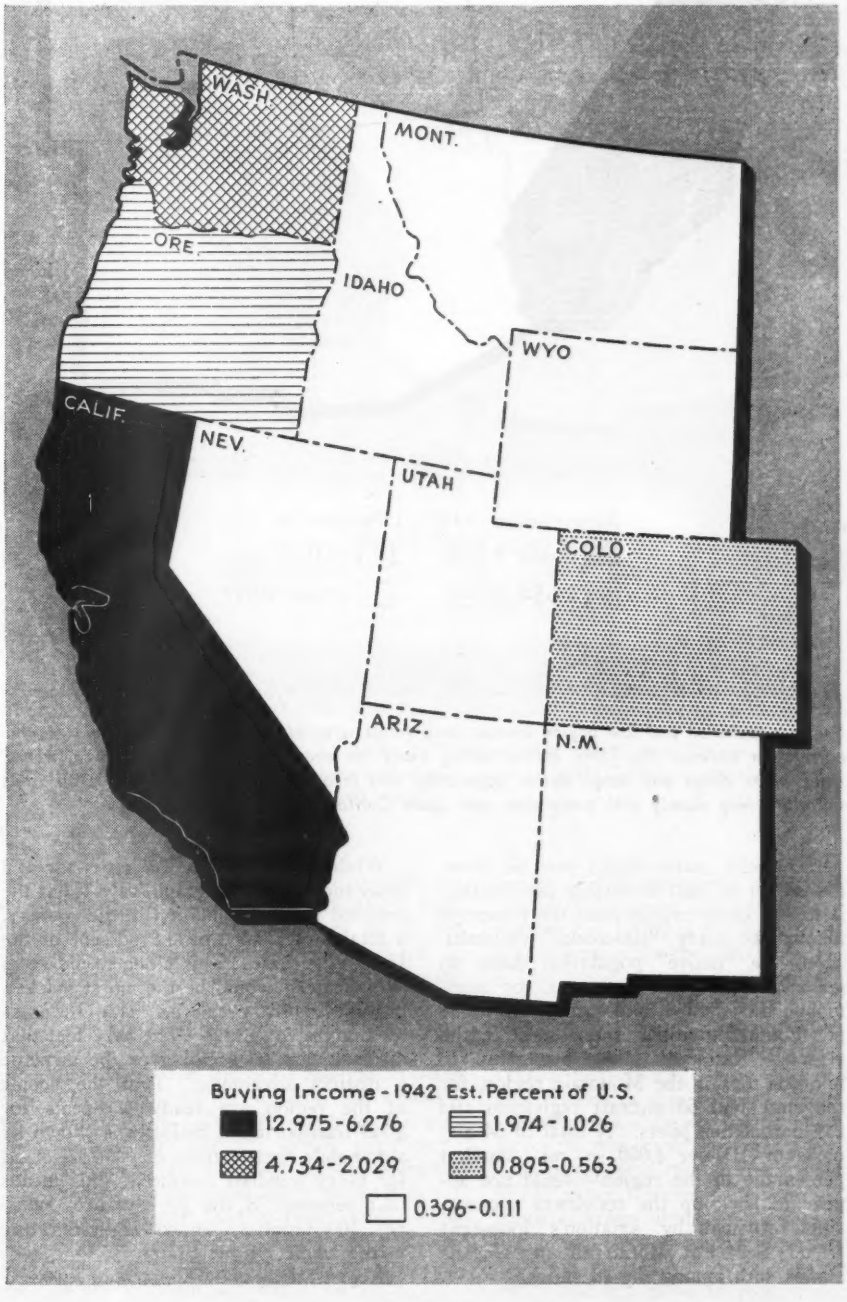
Utah at 40th place among the states, also conforms to the Mountain pattern of sparse family population, the 139,487 total being just 0.5 percent of the national total, and automobile ownership holding up to a good cars-per-hundred-family ratio of 79, with a total of 110,033. Again

Table VIII—Mountain Region

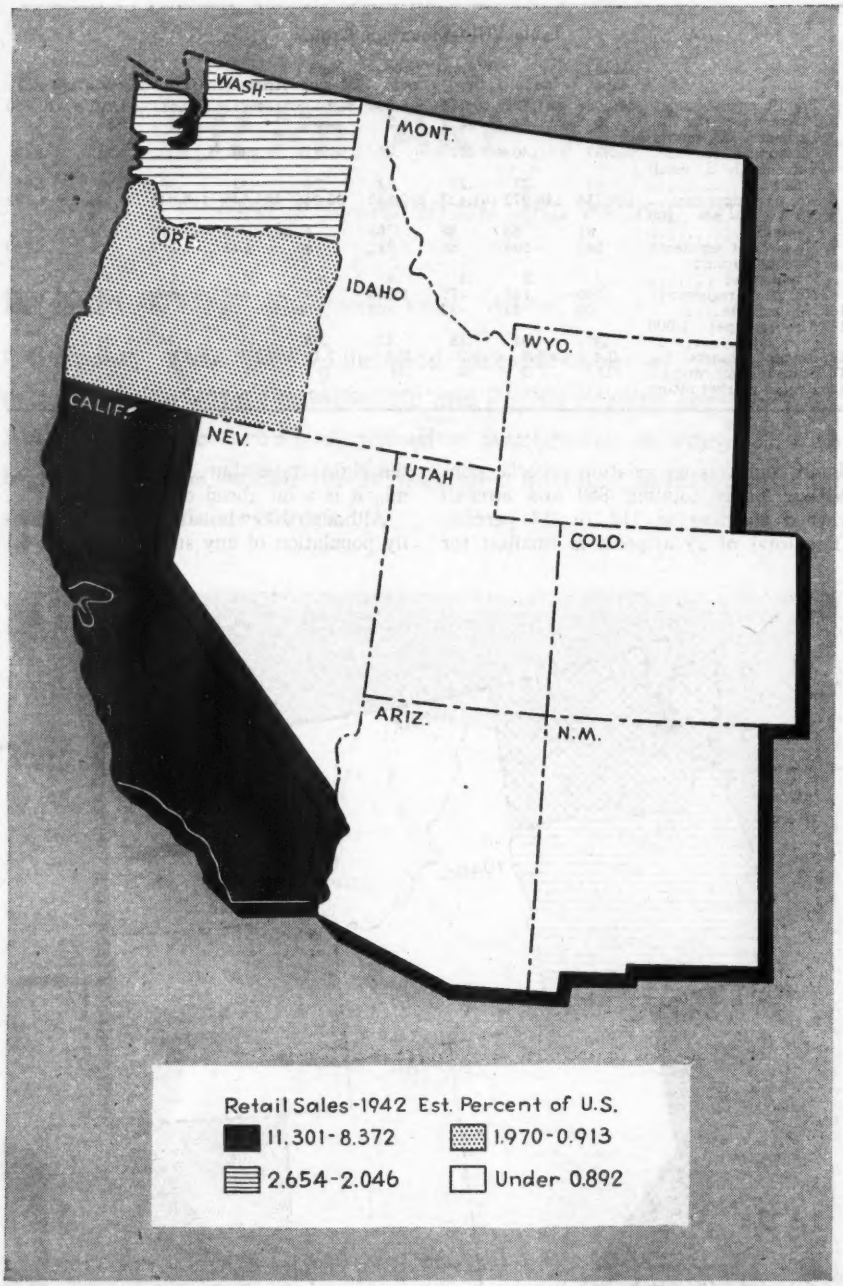
	Montana	Idaho	Wyoming	Colorado	New Mexico	Arizona	Utah	Nevada	Total
1. Family pop.	159,963	141,727	69,374	316,000	129,475	131,133	139,487	33,291	1,120,450
2. Percent nat'l pop.	.6	.5	.2	1.2	.3	.4	.5	.1	3.8
3. Percent U. S. buying income	.37	.30	.17	.71	.21	.30	.32	.11	2.49
4. Percent U. S. retail sales	.42	.37	.21	.82	.26	.35	.38	.14	2.95
5. No. passenger cars	129,758	116,972	61,423	279,849	80,046	103,545	110,033	30,126	911,752
6. No cars per 100 families	81	83	88	89	62	79	79	91	.....
7. No aircraft registered	163	106	86	222	143	142	112	66	1,040
8. Percent aircraft registered	.7	.5	.4	.9	.6	.6	.4	.3	4.4
9. No. pilots registered	786	748	471	1,339	542	657	860	249	5,652
10. No. airports	69	42	35	47	60	70	29	34	386
11. Airports per 1,000 sq. mi.	.47	.51	.35	.45	.48	.61	.36	.31	.....
12. Percent airports	2.4	1.5	1.3	1.7	2.1	2.5	1.0	1.2	13.7
13. State market rating	D	D	E	D	D	D	E	E	.....
14. Region market rating	.....	.....	.....	.....	.....	.....	.....	.....	.8

Utah conforms on aviation criteria, non-airline pilots totaling 860 and aircraft owned standing at 112, or 0.4 percent. The total of 29 airports is smallest for the eight states, but at .36 per 1,000 sq. mi., it is a bit ahead of Nevada.

Although Nevada has the smallest family population of any state—33,291 or 0.1



Buying income index of Mountain region states correlates exactly with family population as shown by comparison with illustration on opposite page. Correlation between the two indices is exact in California also, but in both Washington and Oregon, ratings for buying income is one range higher than population, a healthy sign for both manufacturers and sales organizations now making aggressive merchandising plans.



Sparse population and low buying income keep retail sales at low levels in Mountain region, correlation between the three indices being exact for every state except Colorado, where sales index drops one range below population and income. In Pacific states, retail sales correlate very closely with population and again California hits top range.

percent—the state should not be overlooked for at least dealership possibilities, if for no other reason than the prospects among its many "six-weeks" residents. Even the "native" population make up good transportation prospects, for automobile ownership stands at 30,126, or 91 per hundred families, the highest in the region. Ratio of plane ownership to pilots is tops in the Mountain region, for the state had 66 aircraft registered and 249 non-airline pilots. A total of 34 airports or .31 per 1,000 sq. mi.—smallest percentage in the region—would not appear to back up the consistent sponsorship provided by aviation's long-time friend, Sen. Pat McCarran, for Nevada stands 46th among the 48 states.

While the Mountain Region is far and away the largest, geographically, it has the smallest family population in the country, a total of 1,120,450 or 3.8 percent of the U. S. aggregate. This alone would seem to indicate it would be the worst market, but the contrary can be made the case by aggressive selling. The very fact that distances are so great gives the airplane a distinct advantage. That the people of the region are ready prospects for good transportation facilities is shown by automobile registrations of 911,752, or 81 for every hundred families. This means that between 78 and 85 cars are owned per 100 families, second highest rating in the whole United States.

Registrations of 1,040 private planes exceeds that of the East South Central region, whose population is more than twice as great, and the total of 5,652 of non-airline pilots registered is above both the East South Central and New England regions.

Adequate facilities appear to be one of the greatest deterrents to broader acceptance of private flying, for although the 386 landing fields comprise 13.7 percent of those throughout the country, the average of .45 per 1,000 sq. mi. leaves much to be desired. That private flying can have unusual utility in this region is shown by consistently good weather, for this area is the most fog-free in the whole country. Practically the entire region has, according to Weather Bureau maps, less than five days fog per year, with only small sections of the northwest and east-central portions having between five and ten days per year.

Pacific Region

California not only produces airplanes—its people very definitely own and fly them. Measurable data, as shown in Table IX, rank the state as a Class A market, second only to New York in importance for the country as a whole.

The 10,657 non-airline pilots registered give the state a total of more than twice that of any other, most conclusive indication that private flying has long been accepted in a large way. Its ownership of 2,292 planes (9.8 percent of the national total) is exceeded only in Pennsylvania, where registrations on the last available date were 2,372 or 10.2 percent. The correlation between available landing facilities and the growth of private flying is forcibly shown here; for California, with 227 airports tops the nation, even though other states may have more per 1,000 sq. mi. And, unlike some of the southern states, military installations for training purposes appear now to have much better locations for possible postwar civilian use, since they are closer to population centers.

On non-aviation criteria, California stacks up well also. Its 2,138,343 family population make up 6.2 percent of the national total, but buying income percentage

(*Turn to page 123*)

Table IX—Pacific Region

	Washington	Oregon	California	Total
1. Family pop.....	537,337	337,492	2,138,343	3,013,172
2. Percent nat'l pop.	1.6	.9	6.2	8.7
3. Percent U. S. buying income	2.03	1.11	8.54	11.68
4. Percent U. S. retail sales.....	2.20	1.30	8.37	11.87
5. No. passenger cars.....	441,234	306,540	2,261,938	3,009,712
6. No. cars per 100 families.....	82	91	106	.....
7. No. aircraft registered.....	404	310	2,292	3,006
8. Percent aircraft registered.....	1.7	1.4	9.8	12.9
9. No. pilots registered.....	2,420	1,421	10,657	14,498
10. No. airports.....	61	46	227	334
11. Airports per 1,000 sq. mi.....	.91	.47	1.45	.....
12. Percent airports.	2.2	1.6	78	11.6
13. State market rating.....	B	C	A	.....
14. Region market rating.....	.....	.....	.....	*3*

HERE ARE YOUR MARKETS

AVIATION'S distribution framework for aircraft, parts, and accessories, a framework in which any dealer any place in the United States would be within 3½ hr—at 100 mph. cruising speed—of his distributor. Established on the basis of today's airports (some 3,000 potential dealer locations) it is presented as the basis upon which the aircraft industry can—with aggressive merchandising—more than double the number of major outlets.

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Minneapolis
Buffalo
Chicago
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Philadelphia
Davenport
Cleveland
Moline
Baltimore
Omaha
Des Moines
Columbus
Washington
Kansas City
Cincinnati
Indianapolis
St Louis
Nashville
Tulsa
Atlanta
Little Rock
Dallas
Houston
Miami
★—Potential Distribution Centers
○—Airports

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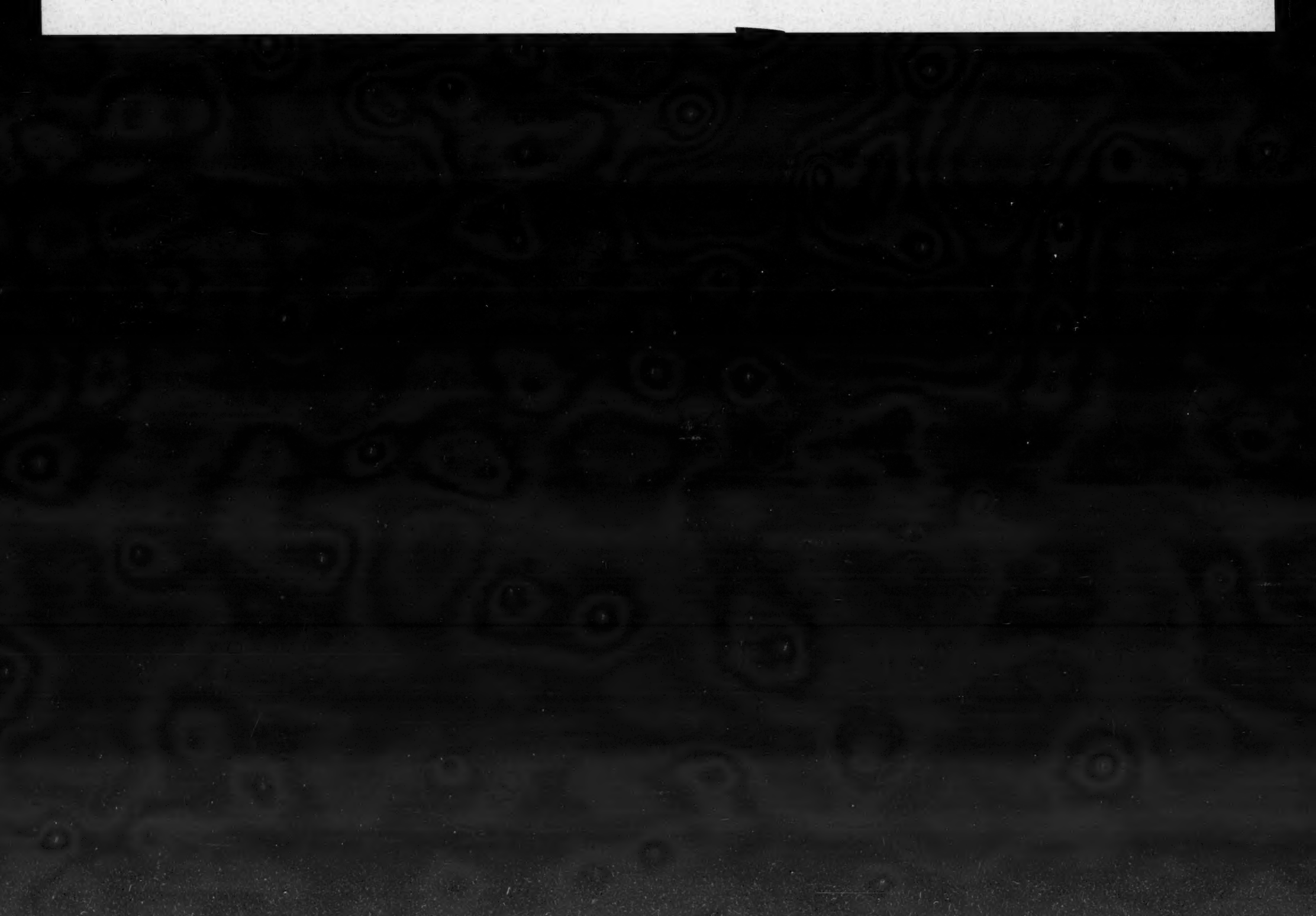
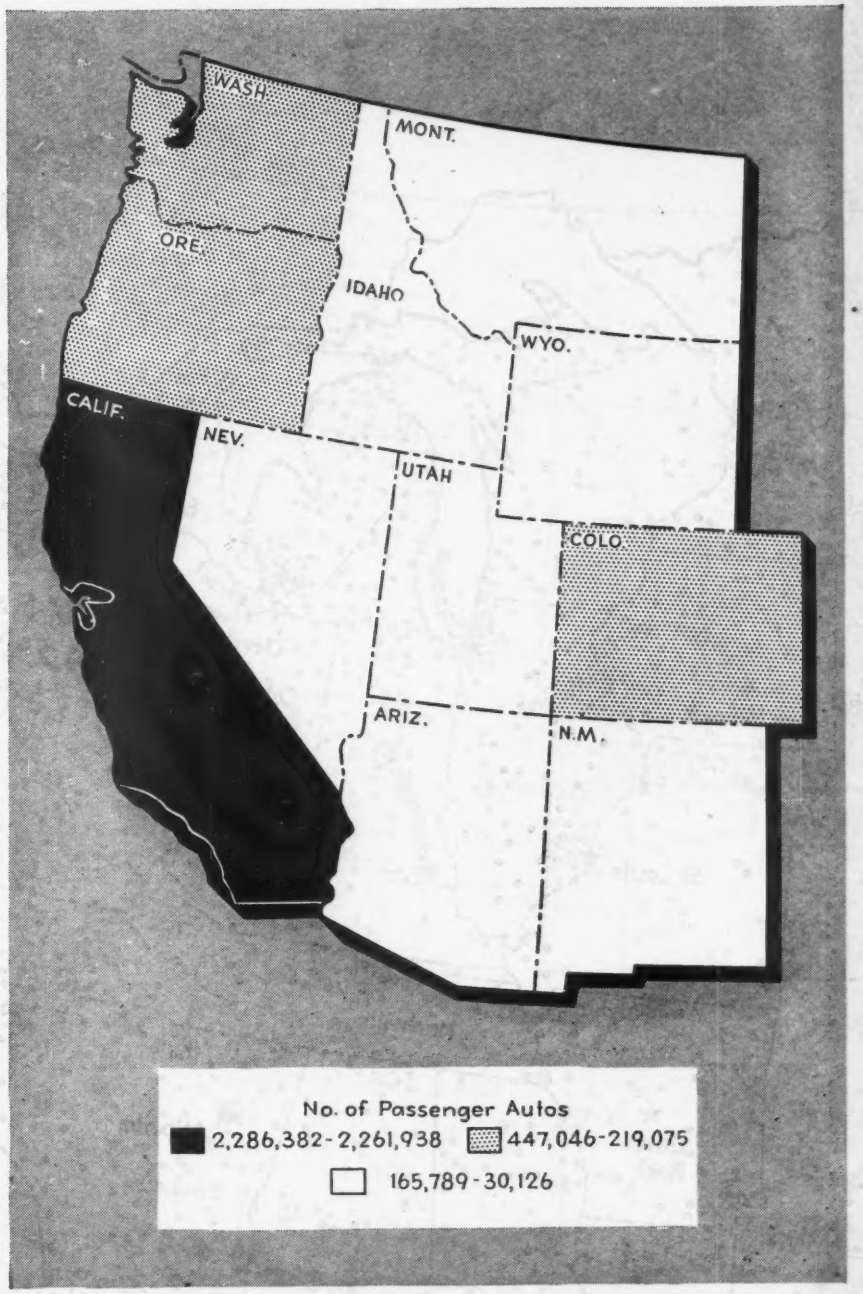


Table X—Temperature and Precipitation Averages

(With high and low marks for Dec. 1943 as an additional guide to winter weather conditions prevailing in the marketing regions.)

State	Temperature			Precipitation		
	High	Low	Ave.	High	Low	Ave.
Alabama	83	9	47.3	5.72	1.11	3.50
Arizona	80	−8	42.6	4.14	.33	1.50
Arkansas	82	−5	40.7	5.58	1.88	3.43
California	83	−8	46.2	12.86	.33	3.30
Colorado	65	−25	26.8	2.96	.02	.77
Florida	89	14	59.4	6.43	.00	1.62
Georgia	87	2	47.4	6.30	2.36	3.80
Idaho	65	−35	27.8	7.93	.12	1.15
Illinois	69	−12	29.3	2.92	T	1.27
Indiana	67	−10	30.0	2.65	.09	1.16
Iowa	65	−13	26.2	1.38	T	.52
Kansas	68	−21	30.8	3.65	T	1.50
Kentucky	68	−1	35.2	3.79	1.07	2.20
Louisiana	86	10	51.5	8.37	1.46	5.22
Maryland-Delaware	69	−15	34.5	2.50	.71	1.41
Michigan	52	−25	24.3	5.07	.04	.82
Minnesota	52	−28	19.9	.44	.00	.07
Mississippi	82	9	47.5	7.00	2.02	3.91
Missouri	72	−20	31.3	3.93	.76	2.10
Montana	69	−29	25.9	2.81	T	.42
Nebraska	68	−20	29.3	1.95	.00	.16
Nevada	70	−16	33.6	2.57	.00	.86
New England	59	−37	21.7	2.33	.40	.99
New Jersey	62	−10	31.1	2.31	.22	1.41
New Mexico	74	−29	31.8	5.08	.00	1.42
New York	59	−34	23.3	2.25	.06	1.11
North Carolina	82	−5	41.8	5.89	1.06	3.36
North Dakota	65	−22	21.5	.41	T	.12
Ohio	63	−10	29.4	2.28	.24	1.03
Oklahoma	78	−8	36.2	5.22	1.06	3.10
Oregon	70	−10	33.6	12.32	.18	1.68
Pennsylvania	63	−23	28.4	3.23	.45	1.12
South Carolina	84	7	46.0	5.32	1.89	3.94
South Dakota	69	−23	26.5	.95	.00	.11
Tennessee	72	−2	39.0	5.19	2.00	3.21
Texas	88	−2	46.5	7.53	.50	2.83
Utah	64	−20	29.6	2.56	.01	.98
Virginia	79	−3	37.1	4.16	.90	2.17
Washington	72	−6	33.0	22.67	.04	3.22
West Virginia	66	−15	32.1	4.20	.45	1.96
Wisconsin	57	−21	22.7	1.08	.00	.27
Wyoming	69	−26	24.6	2.69	.04	.52



Passenger car registrations, as guide to transportation habits, also follows pattern set by other indices for both Mountain and Pacific regions, with California showing highest ratio with 2,261,938 cars for 2,138,343 families.

is higher—8.54 percent—as is the figure for retail sales, which stands at 8.37. On the measure of transportation needs, automobile ownership of 2,261,938 shows up at more than one per family, at a ratio even slightly higher than that in Michigan, heart of the country's auto industry.

Oregon, much smaller geographically, measures out as a Class C market for aviation products in 27th place on a nationwide basis. Its 337,492 family population comprises 0.9 percent of the nation's total, but its buying income stands at 1.11 percent and the state does 1.30 percent of the country's retail sales. That Oregonians are good transportation prospects is shown by passenger car registrations of 306,540, almost one per family.

In the ratio of aircraft ownership to family population, Oregon is above average for the country, with 310 planes registered, or 1.4 percent of the national total, as it also is in the number of non-airline pilots, which totals 1,421. Both these figures would undoubtedly be raised with an increase from the present total of 46 airports, or .47 per 1,000 sq. mi.

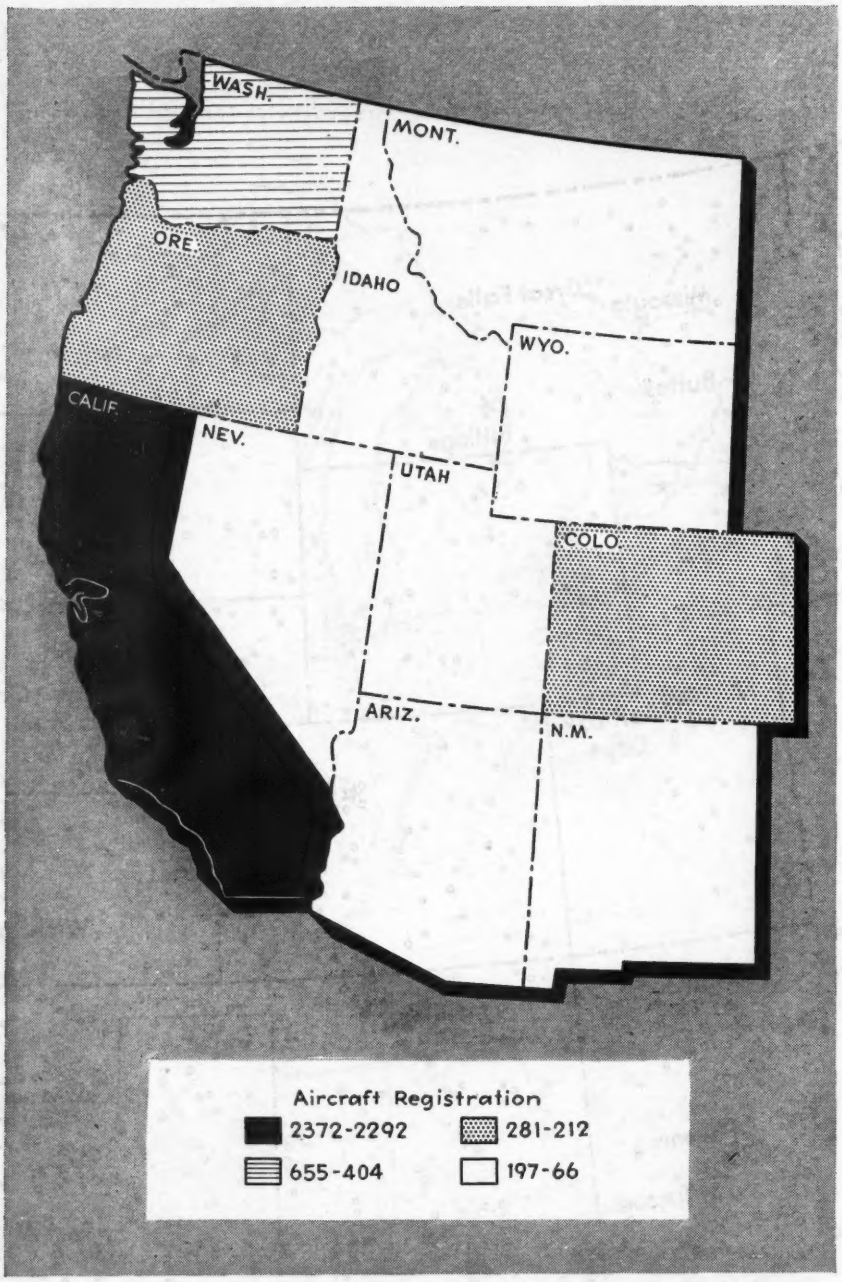
Consistent with the ratios of the Pacific region's other two states, Washington's 1.6 percent of the family population has 2.03 percent of the buying income and does 2.20 percent of the national retail sales. Four of every five of the families own a passenger automobile, for the total stands at 441,234.

There are approximately six pilots to every plane, the respective totals being 2,420 and 404, the latter comprising 1.7 percent of the national registration. These two figures might easily be materially increased with more landing facilities, since the state's airports number 61, or .91 per 1,000 sq. mi. On a weighted basis of presently measurable data, Washington ranks in 15th place among the states.

Boosted in every category by California's impressive figures, the Pacific region makes up the third ranking aviation product marketing area in the country. The 3,013,172 families make up 8.7 percent of the national family population; they have 11.68 percent of the country's buying income and have accounted for 11.87 percent of the retail sales. The total of 3,009,712 passenger car registrations gives the highest ratio of cars to families in the country.

The 14,498 non-airline pilots make up the second largest regional total, topped only by the 15,160 in the East North Central region, while the 3,006 private planes —12.9 percent—make up the third highest total, trailing the Middle Atlantic's 4,703 and the East North Central's 4,658. The total of 334 airports gives the Pacific region fifth place among the country's nine regions in this category.

Southern California chambers of commerce to the contrary, there *are* areas with better year-round flying conditions, for Weather Bureau maps show that the annual average number of days with dense fog in that section ranges from 20 to 40, dropping to 10–20 in the central coastal region and increasing to over 50 along the



In aircraft registrations—one of best clues to past acceptance of aviation—California again has highest rating of any state in Pacific or Mountain regions; in fact its total of 2,292 is outranked only by Pennsylvania's 2,372.

northern coast of the Pacific region. On the whole, however, weather will be much less of a limiting factor in marketing aircraft and aircraft products in this region than in some others, especially in view of the past record hung up by the far western states.

The Distribution Framework

With the various aviation marketing data compiled and analyzed by individual states and regions, the final step is to correlate them on a nation-wide basis as a guide for establishing distributor and dealer areas.

Exact locations for each will, of course, vary with each company's policy, the price of its products, perhaps the present distributor-dealer set-up, and other factors. In a study such as this, presenting basic data for the use of both producers and distributors, it would be unwise today to arbitrarily state that "a distributor should be located here, and dealers located there or there." It is, in fact, impossible for even an individual at this time to say "we will put a distributor here and a dealer there;" somebody else may get that distributor or dealer first, in which case an alternate must be selected.

There are, however, certain basic factors that will apply in every case, so that an over-all framework can be set up, a framework within which each individual manufacturer, or potential distributor or dealer can establish his own pattern.

In suggesting the various distribution areas, one fundamental premise has always been kept in mind: That is, in any organization that is to be able to guarantee one-day delivery to any dealer, the network of distributors must be so complete that every dealer in any particular distribution area will be no more than a 7-hr. round-trip flying time from his distributor. On the basis of 100 mph. cruising speed, this would mean that distribution areas would have a radius of not more than about 350 mi.; in most cases it would probably be less.

Such a network would call a minimum of some 20 distribution points, but it is obvious that population and wealth concentrations, high aircraft registrations, and large numbers of airports would indicate support—in fact the need—for more distribution units than this bare minimum.

We have, therefore, selected 37 areas including 46 possible locations which not only meet the geographic qualification, but provide the framework within which a distributing organization could be set up, with each organization making its own choice of final locations that would best cover the territory for that particular company.

The Distribution Centers

In the country's No. 1 marketing region —the Middle Atlantic States—it is obvious that the metropolitan New York City area provides a very important distribution point, a point which would call for locations either on Long Island, in Westchester County, nearby New Jersey, or, perhaps, in all three. Since the Middle Atlantic region embraces 7,278,911 families with 25.21 percent of the country's buying income, 4,703 aircraft and 344 airports, additional sales and service facilities might easily be necessary. Spreading them out, then, would suggest these additional possible locations: Buffalo, N. Y., and Philadelphia and Pittsburgh, Pa. It should be noted that possible distribution points only have been suggested; dealer locations are outside the scope of this study.

Despite the fact that all, or at least part, of Connecticut, could best be served by the New York distribution center, Boston is the logical point from which to cover the remainder of the New England region which, with part of Connecticut, would embrace approximately 2,000,000 families and some 125 airports. If an additional outlet proves necessary, Portland, Me., appears the most logical, especially in view of its location on the coast for amphibious or water-based craft.

The eight South Atlantic states, stretching from Delaware to Florida and making up the fourth most important region, run smack into the overlapping of territories noted earlier in the series. Under the straight geographical formula, for example, distributors at either Philadelphia or Pittsburgh would extend well into the South Atlantic region. However, it must be remembered that both population and wealth are concentraded in this section of the country. Therefore, it is apparent that a distributorship might well be

established in either Baltimore or Washington, to cover the territory from, say, the Pennsylvania line southward, including Maryland, Delaware, Virginia, and West Virginia. As the population and wealth become more sparse toward the south, the next distributing point would logically appear to be Atlanta, to cover North and South Carolina, Georgia, and northern Florida as part of its territory. The southern half of Florida and, possibly, the Bahamas and Cuba, could be serviced by a distributing center located in Miami.

Due to many similarities in terrain, weather, and economics, the lower half of the East South Central region—the states of Alabama and Mississippi—might well be served from the Atlanta distributorship. However, if the region, also including Kentucky and Tennessee, appears to require separate coverage, a distributing point located at Nashville would nearly meet the requirements of having the most remote dealer no more than 350 mi. away from his distributor.

Midwest Sales-Service Centers

While the five states of the East North Central region constitute a much smaller geographic area, it must be remembered that they comprise the nation's second most important marketing region and therefore will require greater concentration of sales and service facilities.

It would appear that the two most obvious spots would be Chicago and/or Detroit. Additional locations (if more coverage proves necessary) which would give a good geographic distribution throughout the territory would include: Cleveland, Columbus, and Cincinnati, Ohio, the latter probably overlapping into Kentucky. Indianapolis appears logical for the southern portion of the Hoosier state. Perhaps not all these would be distributor points; at least they would be pertinent for large dealerships.

Moving now into the seven West North Central states—making up the fifth most important region—the northernmost territory would best be served from a distributorship in the Twin Cities, Minneapolis or St. Paul, a point which could cover the eastern portions of both North and South Dakota. Omaha could serve all or most of Nebraska and western Iowa. Although some organizations might choose Des Moines for its central Iowa location, the state could also be served from a unit located in Davenport or in Moline, Ill., both of which are in an almost direct line from Chicago.

Eastern Kansas would naturally come in the market sphere of Kansas City, which could also handle the western part of Missouri. The eastern part of Missouri falls into the sphere of St. Louis, which would overlap into southern Illinois.

Unless the products are in a price range where very complete coverage is essential, the state of Arkansas could probably be served from St. Louis or a distribution center located in the West South Central region in either Tulsa or Oklahoma City. If, however, the products are in the bracket suggested, a distributor might logically be established in Little Rock. Note that the suggested location is "either Tulsa or Oklahoma City;" both are wide awake aviation cities, hence the choice between them is something each sales manager will have to decide for himself.

In Kansas, by far the leading aviation center is Wichita, home of three major league aircraft builders of which at least two can be counted on as important factors in the personal plane production field. It would be natural to assume that each would represent a distribution point, and it would be up to each individual manufacturer, distributor, or dealer to determine for himself if he wanted to attempt an invasion right in these companies' own "front yard."

This point of "front yard invasion" will come up in several areas, particularly along the East and West Coasts (as shown by the complete list of a aircraft manufacturers given in Aviation's 11th Annual Directory Issue, published last February). It is an important factor, for such matters as delivery price and service facilities must be considered.

In Texas there is again the matter of choosing between two leading aviation cities—Dallas and Fort Worth. And again the selection must be made by each individual distribution head. Although the Dallas-Fort Worth location would cover most of the state, with the 350-mi. radius qualification, the need for more distribution facilities would logically lead to such additional establishment in Houston or San Antonio.

If the 350-mi. network is to be maintained, it will be necessary to establish a distributor at El Paso to cover west Texas and New Mexico. Keeping this chain unbroken would also call for at least one distributor in Arizona, where the logical location would be either Phoenix or Tucson, both of which have long been good flying centers. All three of these locations, it should be remembered are adjacent to or near northern Mexico.

Denver shows up as the number one choice in Colorado, also possibly covering part of Western Kansas and southern Wyoming, while Salt Lake City could serve all of Utah plus portions of Wyoming and Idaho.

If manufacturers intend to see that no part of the country is more than about 350 mi. from a distributor, one, or possibly two, should be set up in Montana. One at Billings would serve eastern Montana and Western North Dakota, ranging over to the territory serviced from the Minneapolis-St. Paul area; the other at Great Falls, Missoula, or Butte, would cover the western part of the state, as well as part of Idaho.

Center of the northwest sphere of the Pacific region is Seattle, from which the 350-mi. radius would cover all the state of Washington and most of Oregon. However, concentration of distribution facilities might call for setting up a distributor in Portland, in which case there would be no "uncovered" territory along the Pacific Coast near the California-Oregon boundary, for establishment of a major distribution unit in the San Francisco area would cover not only all of northern California but also part of Nevada. And last, but far from least, Los Angeles would be the logical headquarters for distribution throughout the southern California area.

The Sales Foundation

Here, then, is a distribution "framework" of some 38 economic-geographic centers giving a choice of some 47 cities within which to establish an individual distribution organization. While there will undoubtedly be variants, the measurable data presented indicates that more than one company will have representation in many of the same cities, with more than a good chance that all will not only be able to find profitable outlets for their products but also to insure profitable business for their distributors, and the latter, in turn, can be assured of sound, money-making dealers in the surrounding territory.

The suggested distribution points, it should be remembered, have not been presented as the final word; they are the natural result of measurable data compiled and presented to offer the utmost value to both manufacturers and distributors—actual as well as potential—in the hope that aviation merchandising will progress to the point where the 37 distribution areas will quickly become known as merely the early foundation of a much more complete network.

THINGS TO WATCH

• Factors affecting marketing conditions will vary from time to time and location to location; they must be under constant, close study so that full advantage or counteracting measures can be taken of the changes they bring. Prominent among such factors are these:

Population shifts: **The war has brought marked increases to some areas, it has tended to drain others; the figures should be reviewed at frequent intervals to make sure required number of prospects are available within a given territory.**

Regulations: **Many states, possibly even counties or cities, may be expected to enact additional legislation affecting flying and, consequently, the aviation product distributor's means of livelihood.**

Taxation trends: **Often closely allied with regulatory legislation and a factor which can easily make the difference between black or red ink on the books, taxation trends should be carefully calculated.**

Landing facilities: **Progressive states and communities can speed the growth of personal flying by providing necessary landing facilities. Chambers of Commerce and state aviation commissions can give good clues as to progress likely to be made in this respect.**

Helping a new star

Set a new record

Lockheed built it and called it the Constellation and it broke the Los Angeles-to-Washington speed record by 3 hours and 24 minutes. It develops more than 8,000 hp., cruising at high, over-weather altitudes, and does it faster than many fast pursuit ships.

Normally, the Constellation can accommodate 57 passengers in its roomy air-conditioned cabin. But right now, it is working for Uncle Sam, accommodating as many as 100 fully-equipped men.

Many compact, friction-free Timken Bearings are giving the Constellation the all-important qualities of lighter weight, smoothness of operation, conservation of power, endurance and economical maintenance — as well as maximum radial and thrust load-carrying capacity. If these indispensable aircraft bearing features can help meet your requirements, why not write us. We'll be glad to make recommendations. The Timken Roller Bearing Company, Canton 6, Ohio.

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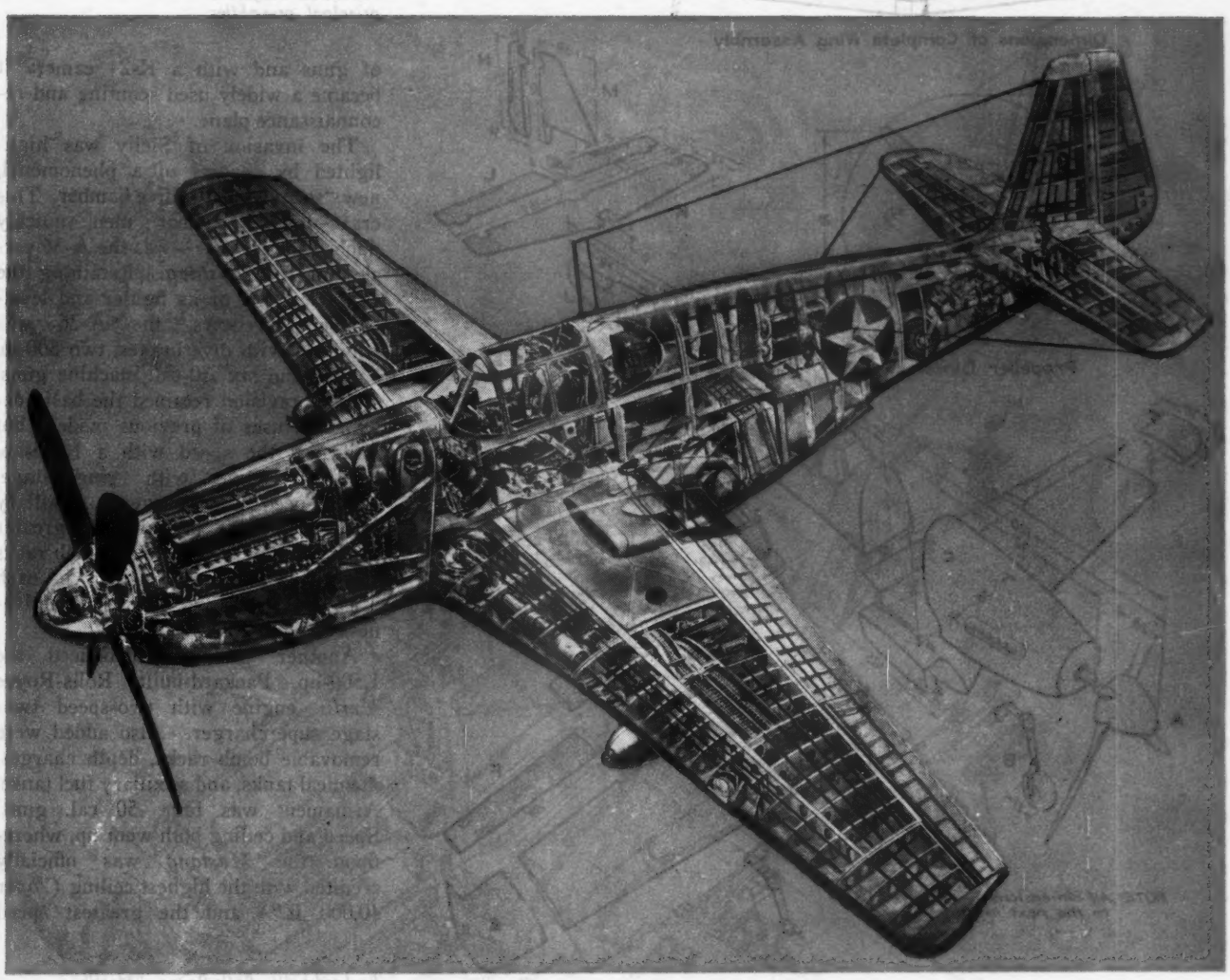
TAPERED ROLLER BEARINGS



DESIGN ANALYSIS NO. 7

The North American P-51 "Mustang"

By WILLIAM R. NELSON, *West Coast Editor, "Aviation"*

AVIATION'S graphic and thoroughly detailed engineering dissection of NAA's great fighter—initially completed less than four months after design inception, then fourfoldly hailed for low-altitude cooperation, dive-bombing versatility, high-altitude fighting speed, and long-range prowess.

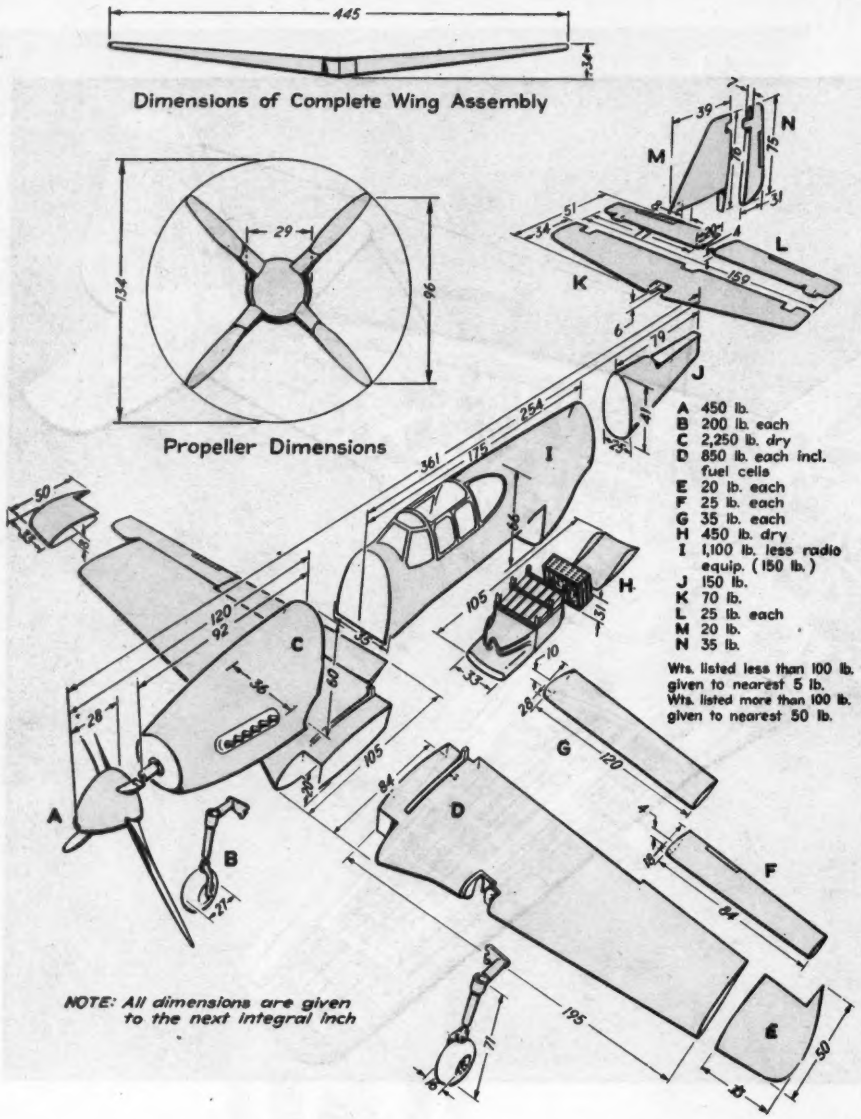
PRIOR TO WORLD WAR II it was generally agreed among aeronautical engineers and military aviation authorities that it was impracticable, if not impossible, to design an airplane capable of accomplishing more than one type of military operation.

The record of North American's P-51 *Mustang* fighter proves, however, that it is both possible and practical to create a single basic design that can be modified, as military needs dictate, to keep abreast of requirements. Among single-seat, single engine fighters, the *Mustang* has been credited as the best low-altitude cooperational craft, the most versatile dive bomber, the fastest high-altitude fighter, and the plane with the greatest range.

All this has been achieved by a plane whose basic design and most of its original specifications remained unchanged. New models incorporated equipment and design refinements but retained the desirable advantages of preceding versions.

The original *Mustang*, designed and built for the British in less than 120 days, was intended for low and medium altitude work. It was a low-wing all-metal monoplane powered by a 12-cyl., V-type Allison engine of 1,150 hp., and it was credited with close to 400 mph. speed. RAF pilots said it was highly maneuverable, had no "cranky" characteristics; and, for those early war days, it was heavily armed, with .50-cal. guns, one on each side of the engine, and one .50 and two .30-cal. guns in each wing. A gun camera was mounted in the left wing.

In its P-51 version for the USAAF, the *Mustang*—retaining its high maneuverability with somewhat increased speed—quickly acquired fame as a "train buster" by virtue of its two 20-mm. cannon in each wing. Stripped


445
34
Dimensions of Complete Wing Assembly
29
134
96
Propeller Dimensions
A 450 lb.
B 200 lb. each
C 2,250 lb. dry
D 850 lb. each incl. fuel cells
E 20 lb. each
F 25 lb. each
G 35 lb. each
H 450 lb. dry
I 1,100 lb. less radio equip. (150 lb.)
J 150 lb.
K 70 lb.
L 25 lb. each
M 20 lb.
N 35 lb.
Wts. listed less than 100 lb. given to nearest 5 lb.
Wts. listed more than 100 lb. given to nearest 50 lb.
NOTE: All dimensions are given to the next integral inch

Tabulated weights of principal assemblies.

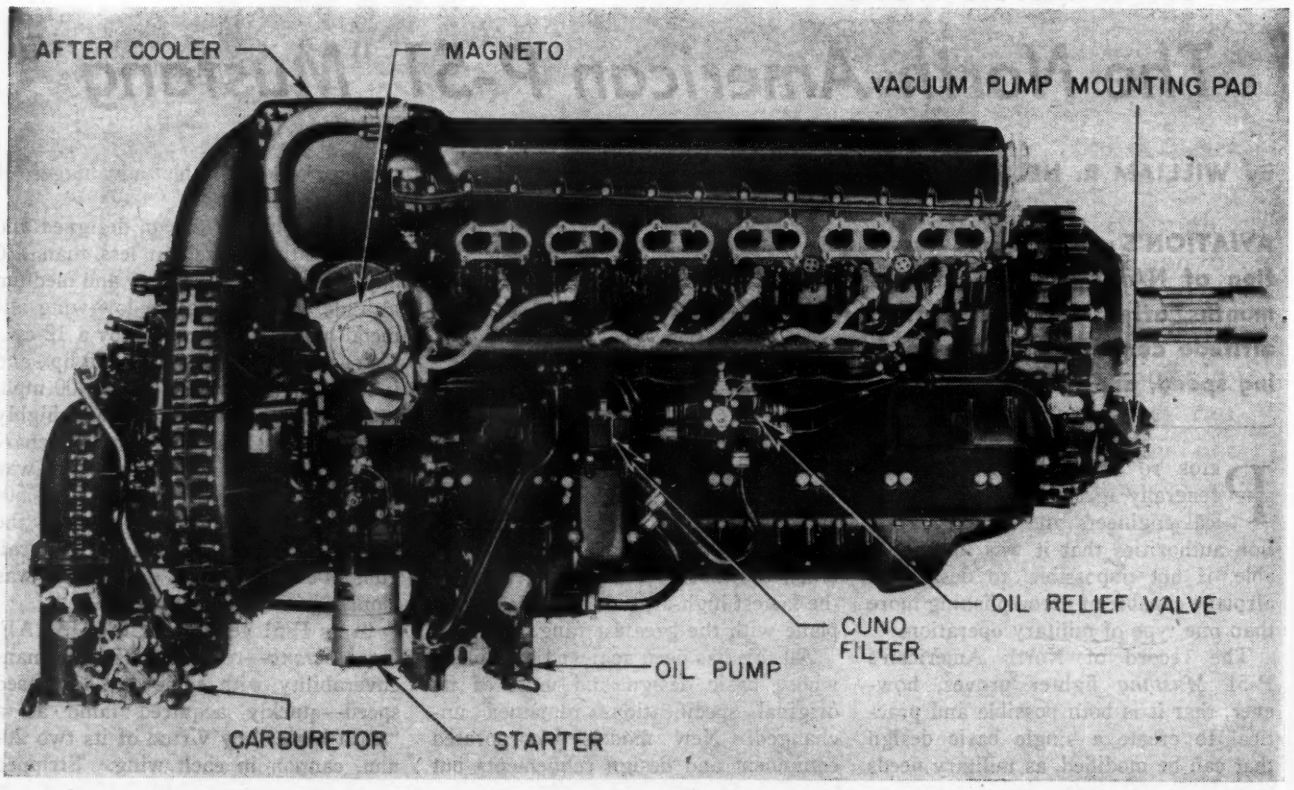
of guns and with a K-24 camera it became a widely used scouting and reconnaissance plane.

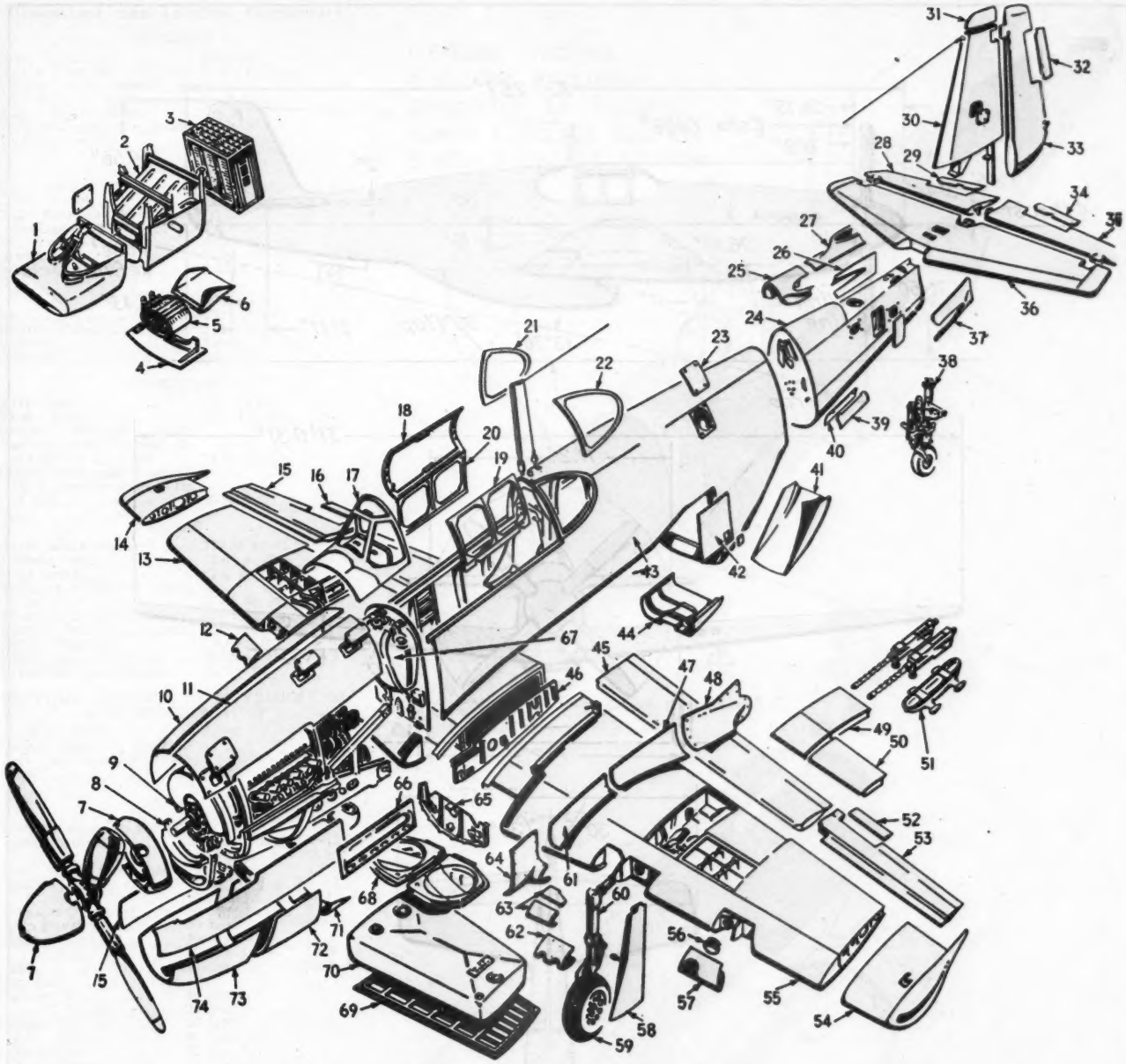
The invasion of Sicily was highlighted by reports of a phenomenal, new "secret" fighter-dive bomber. This craft—which combat men quickly dubbed the *Invader*—was the A-36 version of the *Mustang*. Retaining the characteristics of its fighter and level-bomber forebears, the A-36 was equipped with dive brakes, two 500-lb. bombs, and six .50-cal. machine guns.

Next revision retained the basic design and uses of previous models, but increased the speed with a 1,465-hp. Allison engine with single-stage, single-speed supercharger. Auxiliary fuel tanks gave considerably greater range. Carried were wing bomb racks and four .50-cal. guns, two in each wing, maintaining striking effectiveness against ground targets.

Another revision introduced the 1,500-hp. Packard-built, Rolls-Royce *Merlin* engine with two-speed two-stage supercharger. Also added were removable bomb racks, depth charges, chemical tanks, and auxiliary fuel tanks. Armament was four .50 cal. guns. Speed and ceiling both went up, whereupon the *Mustang* was officially credited with the highest ceiling ("over 40,000 ft.") and the greatest speed

Packard-built Rolls-Royce "Merlin" 1,500 hp. engine used in "Mustang".





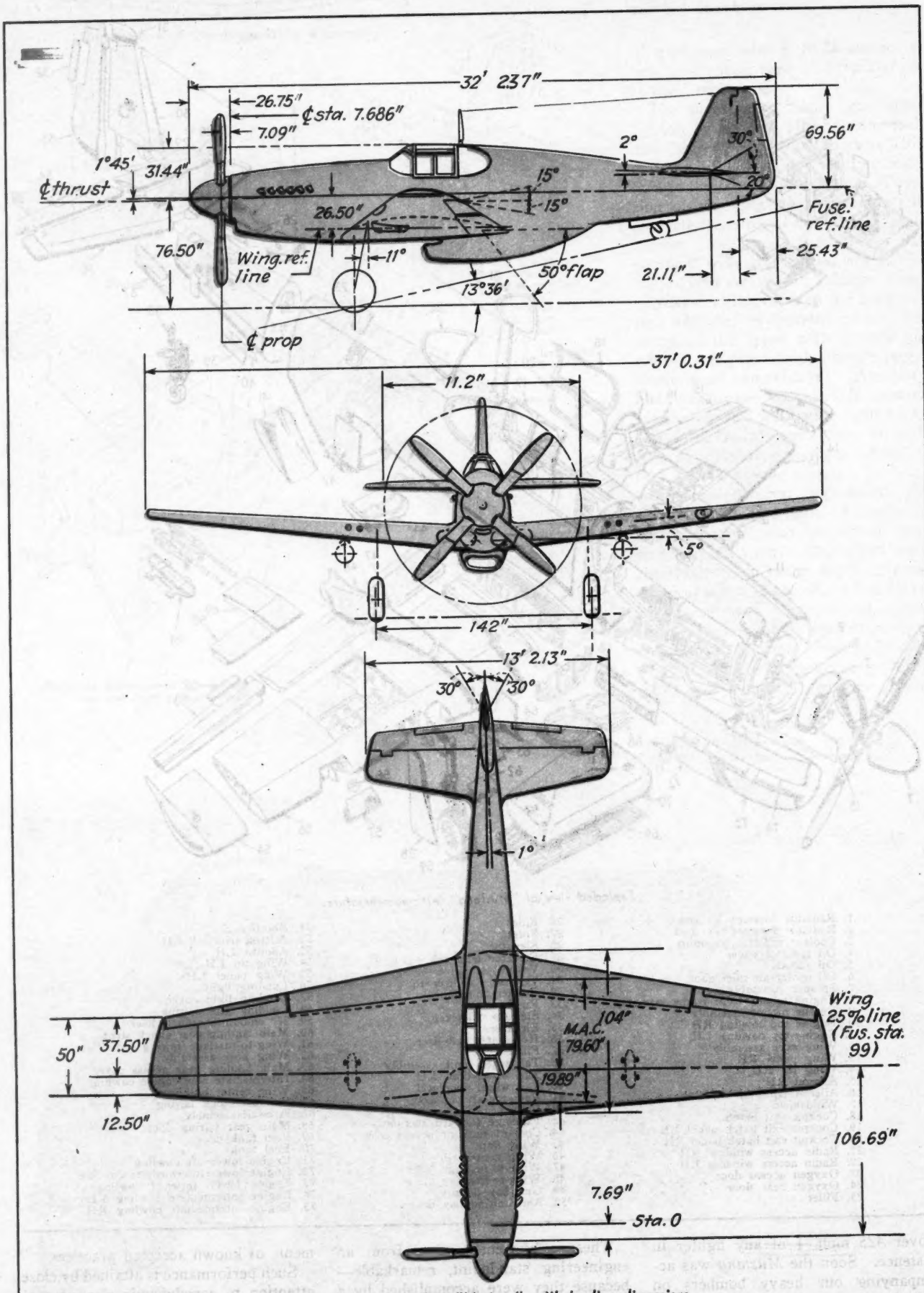
Exploded view of "Mustang", with nomenclature.

1. Radiator forward air scoop
2. Radiator forward air duct
3. Coolant radiator assembly
4. Oil radiator cover
5. Oil radiator
6. Oil cooler air inlet door
7. Spinner Assembly
8. Engine mount front frame assembly
9. Engine mount assembly
10. Engine top cowling RH
11. Engine top cowling LH
12. Wing nose assembly
13. Wing panel RH
14. Wing tip RH
15. Aileron RH
16. Aileron trim tab
17. Windshield
18. Cockpit exit hatch
19. Cockpit exit hatch panel LH
20. Cockpit exit hatch panel RH
21. Radio access window RH
22. Radio access window LH
23. Oxygen access door
24. Oxygen rear door
25. Fillet
26. Fillet
27. Fillet
28. Elevator
29. Elevator trim tab
30. Vertical stabilizer
31. Vertical stabilizer tip
32. Rudder trim tab
33. Rudder
34. Elevator trim tab
35. Elevator
36. Horizontal stabilizer
37. Fillet
38. Tail wheel unit assembly
39. Tail wheel door LH
40. Tail wheel door RH
41. Radiator aft air scoop
42. Cover
43. Fuselage forward section
44. Coolant radiator access cover
45. Wing flap
46. Wing center rib
47. Wing-to-fuselage fillet
48. Wing-to-fuselage fillet
49. Gun bay door
50. Ammunition bay door
51. Bomb rack
52. Aileron trim tab LH
53. Aileron LH
54. Wing tip LH
55. Wing panel LH
56. Landing light
57. Landing light cover
58. Landing gear fairing
59. 27" smooth-contour wheel
60. Main landing gear shock strut
61. Wing-to-fuselage fairing
62. Wing nose assembly
63. Main landing gear access cover
64. Intermediate rear engine cowling
65. Wing center bulkhead
66. Exhaust stock fairing
67. Firewall assembly
68. Main gear fairing door
69. Fuel tank door
70. Fuel tank
71. Engine lower aft cowling
72. Engine lower intermediate cowling
73. Engine lower forward cowling
74. Engine intermediate cowling LH
75. Engine intermediate cowling RH

("over 425 mph.") of any fighter in existence. Soon the *Mustang* was accompanying our heavy bombers on their longest missions, since it possessed the longest range of any single-engine fighter in the war.

These achievements are, from an engineering standpoint, remarkable—because they were accomplished by a plane that does not to any extent embody previously unknown engineering features, but rather employed refinements of known accepted practices.

Such performance is attained by close attention to aerodynamic cleanness of design, employing an efficient, low-drag, laminar-flow airfoil, a modification of an NACA. design. Second-



Three-view drawing of P-51 "Mustang", with leading dimensions.

Dimensions and Leading Particulars

GENERAL

Span	37.03 ft.
Length (over all)	32 ft. 2⅛ in.
Length (tail wheel on ground)	30 ft. 8 in.
Height (tail wheel on ground, propeller blade vertical at top)	12 ft. 6 in.

WINGS

Airfoil section	NAA-NAA low drag
Chord at root	8 ft. 8 in.
Chord near top (215 in. from fuselage centerline)	4 ft. 2 in.
Incidence (variable)	Approx. 1 deg.
Sweepback	3 deg. 35 min. 32 sec.
Dihedral (at 25% line)	5 deg.

STABILIZER

Span	13 ft. 2⅛ in.
Maximum chord	2 ft. 6 in.
Incidence	2 deg.
Dihedral	(none)

FUSELAGE

Width (max.)	2 ft. 11 in.
Height (max.)	6 ft. 3 7/16 in.
Length (without engine mount, front of heat exchanger to tip of tail	24 ft. 2½ in.
Length (with engine mount, tip of propeller shaft to tip of tail)	30 ft. 9 in.

AREAS

Wings (less ailerons)	220.55 sq. ft.
Ailerons (total)	12.64 sq. ft.
Flaps (total)	32.6 sq. ft.
Stabilizer (including elevators)	27.85 sq. ft.
Elevators (including tabs)	13.05 sq. ft.
Elevator Trim Tabs (total)	2.00 sq. ft.
Vertical Stabilizer	8.83 sq. ft.
Rudder (including tabs)	10.25 sq. ft.
Rudder trim tabs (total)	.82 sq. ft.

SETTINGS & RANGE OF MOVEMENT OF CONTROL SURFACES

Stabilizer, fixed	2 deg.	
Vertical stabilizer, fixed offset (from fuselage centerline)	1 deg.	
	Deg.	In. at Max. Chord
Ailerons, wing, Up travel (from neutral)	10 deg. 12 deg. or 15 deg.	2.2 = 2.7 3.3
Down travel (from neutral)	10 deg. 12 deg. or 15 deg.	2.2 = 2.7 3.3
Elevators Up travel	30 deg.	8.63
Down travel	20 deg.	5.9
Rudder, Right	30 deg.	13.5
Left	30 deg.	13.5
Flaps	50 deg.	20.5
Trim tabs		
Elevator, Up	10 deg.	
Down	25 deg.	
Rudder, Right	10 deg.	
Left	10 deg.	
Aileron, Up	10 deg.	
Down	10 deg.	
Tolerance on control surfaces Movements	Approx. ± ¼ deg.	

LANDING GEAR

Type	Hydraul., retract., conventional 3-wheel
Tread	11 ft. 10 in.
Shock struts	Air-Oil Combination
Wheels (magnesium alloy construction) dia	27 in.
Tires (all weather tread)	27 in.
Brakes	Disk, hydraulic
Oleo travel	8 in.

TAIL GEAR

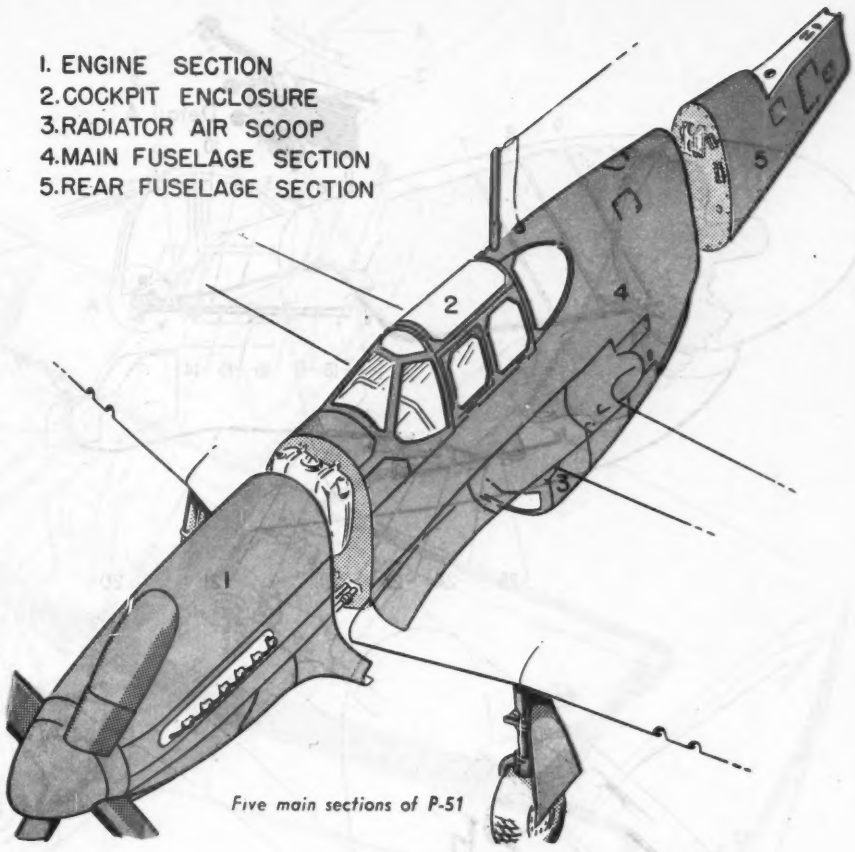
Type	Hydraul., retract., steerable
Shock strut	Air-oil combination
Wheel dia	12.5 x 4.5 in.
Tire (channel tread)	12.5 x 4.5 in.
Oleo travel	7.50 in.

ENGINE

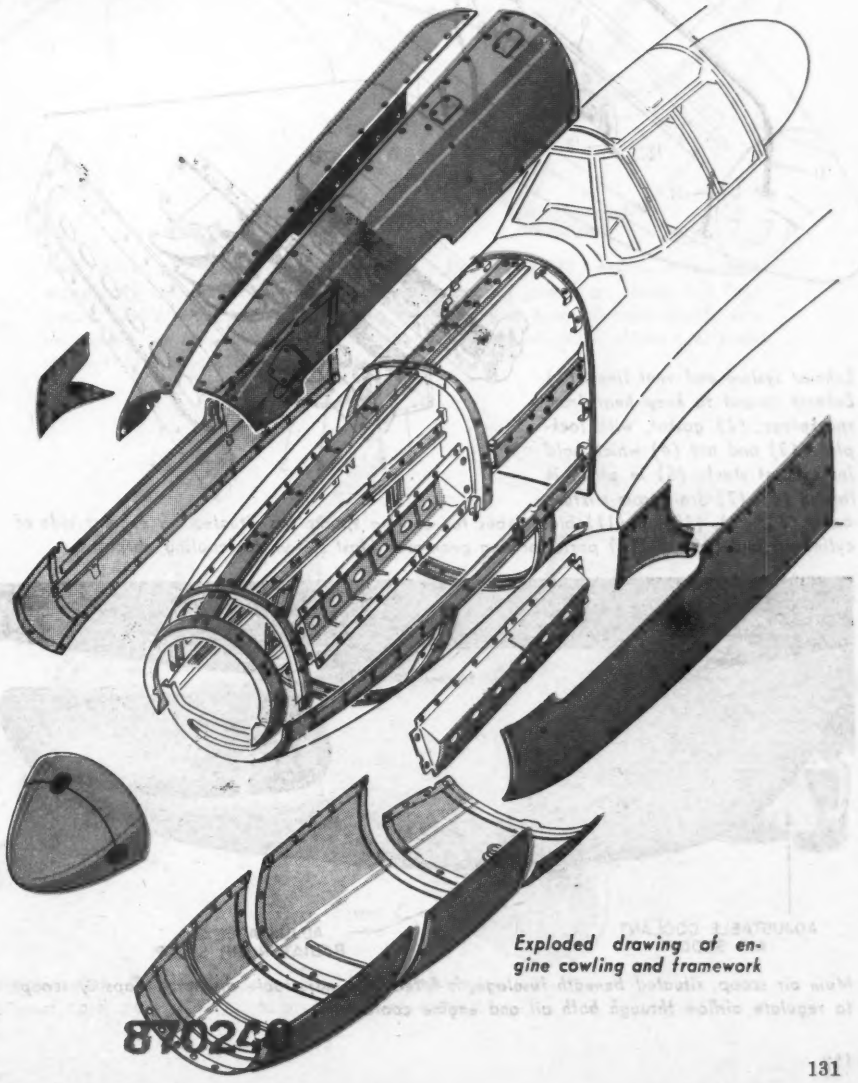
Type	Packard-built Rolls-Royce
Designation	V-1650-3
Number of cylinders	12
Gear ratio	21:44
Coolant (70% water and 30% ethylene glycol by volume)	Type D-Spec. AN-E-2

PROPELLER

Type	Hamilton Standard Hydromatic
Dia	11 ft. 2 in.
Blades	4, paddle type
Pitch setting (hydraulic controlled) Low	24 deg.
High	65 deg.



Five main sections of P-51



Exploded drawing of engine cowling and framework

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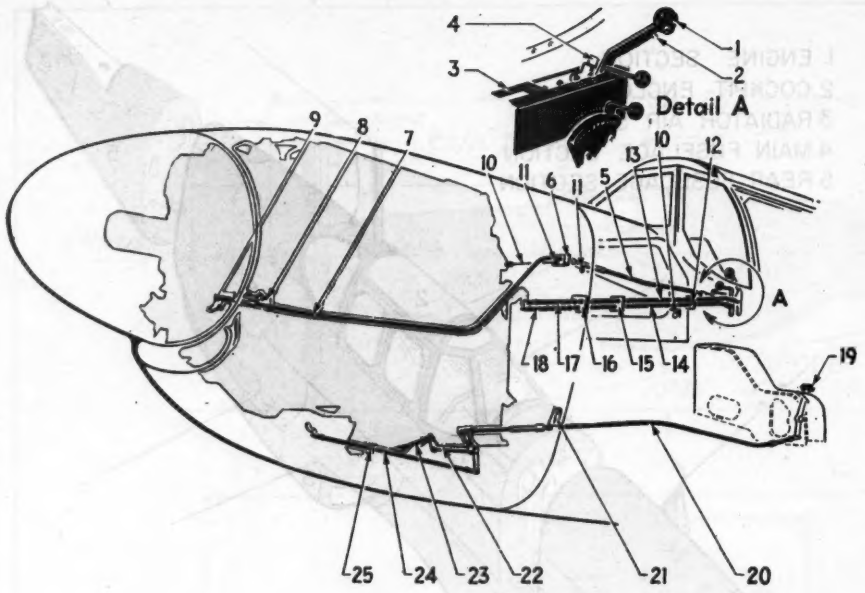
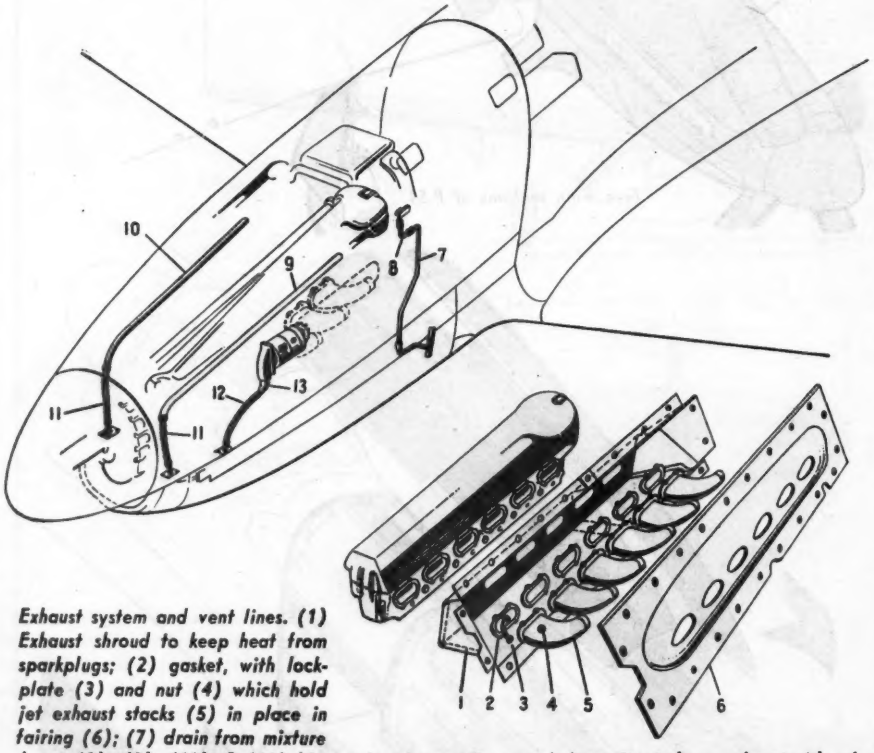
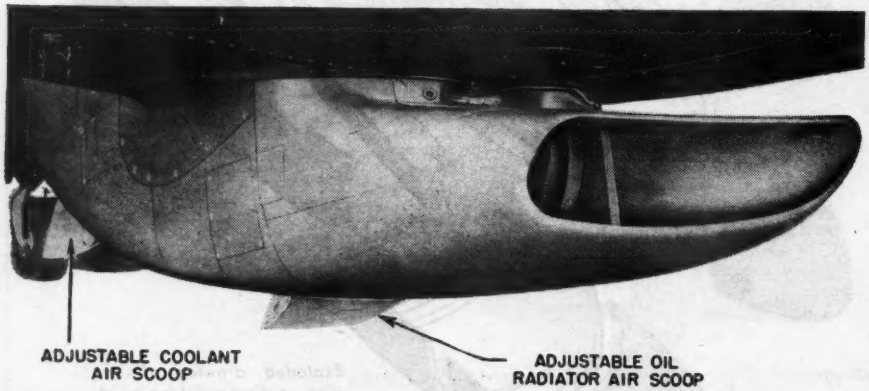


Engine controls. (1) Engine throttle control; (2) throttle stop release; (3) throttle name plate; (4) adjustable throttle stop; (5) quadrant to bellcrank flexible control; (6),-(11), (12), (15), (16), (25) fairleads; (7) flexible control; (8) propeller control bracket; (9) propeller control bellcrank; (10) emergency boost control handle; (13), (14), (17), & (18) control rods to jackshaft; (19) carburetor air control; (20) flexible air control; (21) air control support; (22) jackshaft, hot air control; (23) hot air door actuating rod; (24) air shut-off control rod; and (25) shut-off rod support.



Exhaust system and vent lines. (1) Exhaust shroud to keep heat from sparkplugs; (2) gasket, with lockplate (3) and nut (4) which hold jet exhaust stacks (5) in place in fairing (6); (7) drain from mixture boost (8); (9), (10), & (11) blast tubes for cooling sparkplugs situated on exhaust side of cylinders; and (12) & (13) parts forming generator blast system for cooling purposes.



Main air scoop, situated beneath fuselage, is fitted with adjustable discharge flaps or scoops to regulate airflow through both oil and engine coolers.

degree curves, calculated as mathematical expressions, are employed for external lines of fuselage, fillets, ducting, and air scoop.

The air scoop is located below and just aft of the center of fuselage, where it was found by wind tunnel tests to create less drag, while operating efficiently. Both oil and coolant radiators are contained in the air scoop.

An identifying feature of the *Mustang* is the square wing and tail surface tips, which tended to prevent stalling and to maintain excellent aileron control.

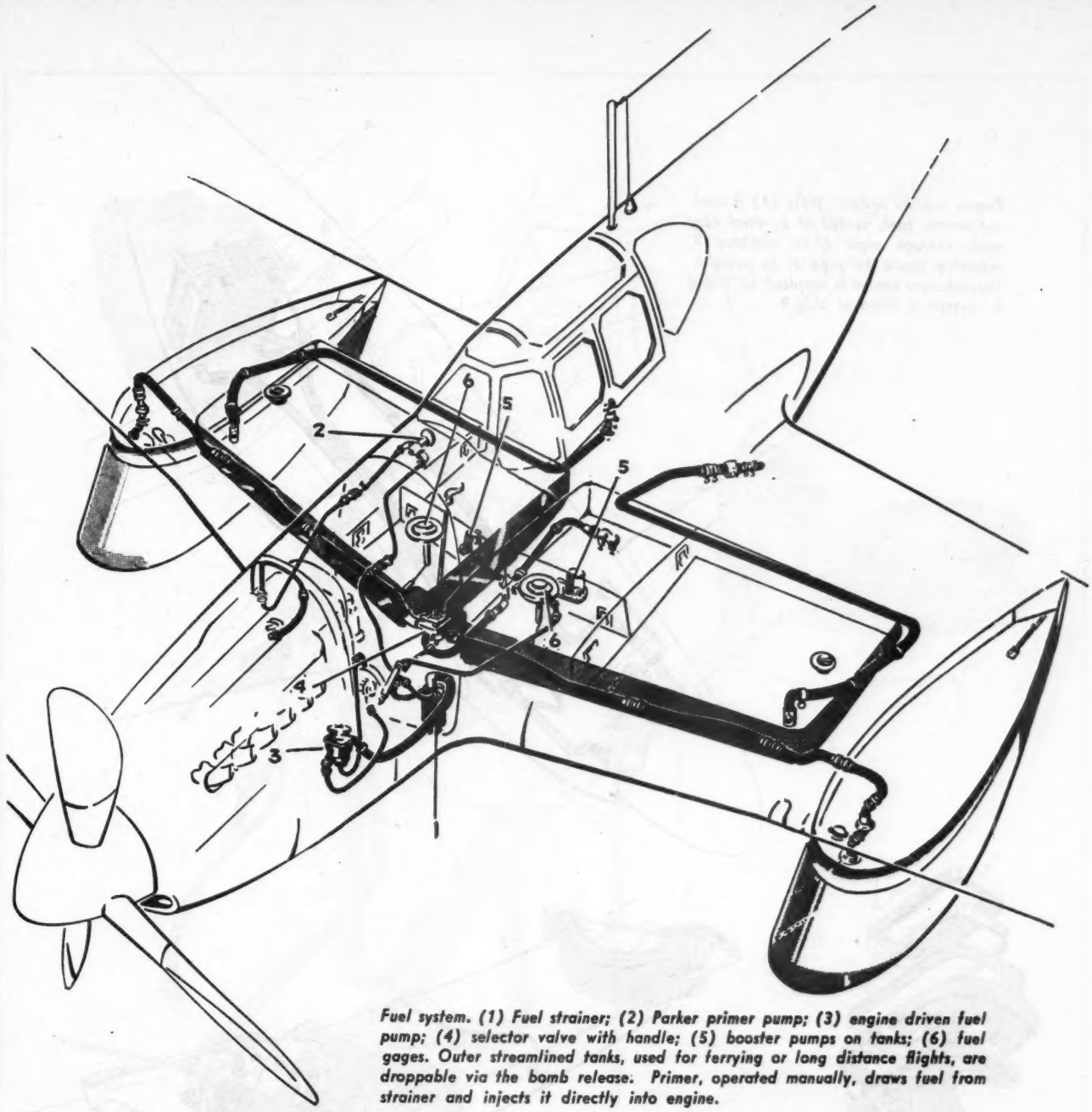
The fuselage, of semi-monocoque construction, is divided into three main sections: Engine mount, main, and rear section, all joined with bolts. With exception of cockpit armor fore and aft, fuselage is entirely Alclad and aluminum alloy extrusions.

Engine mount is a box beam of Alclad sheet and extruded parts, designed so that the engine can be removed as a unit. Mount is attached at the firewall with four bolts.

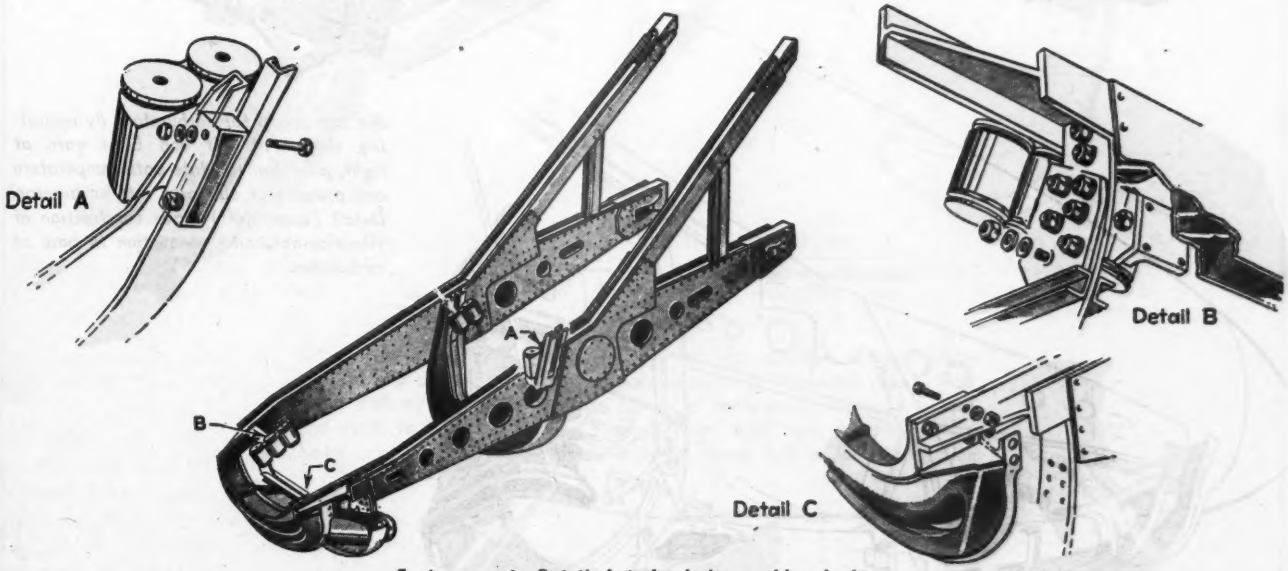
Main fuselage section is constructed around four 24ST extruded longerons, intermediate frames, Alclad covering, and stringers. Stainless steel sheet and armor plate firewall form forward bulkhead. A turnover truss of 24ST extrusions and formed sheet protect the pilot. Upper longerons are extruded H-sections which extend aft from firewall, tapering to T-section and terminating near rear section. Lower longeron, H-beam and U-channel, extends full length of section.

Eight riveted and bolted assemblies which comprise main fuselage section may be removed and replaced as units. They are: Firewall, turn-over truss, upper deck, left and right side panel subassemblies, radio shelf, web assembly, and lower section with air scoop.

Comfort and safety are given consideration in the design of the cockpit seat, which accommodates the seat-type parachute and has a kapok backcushion life preserver, provisions for heating and cooling, and protecting armor plate at the firewall and seat.

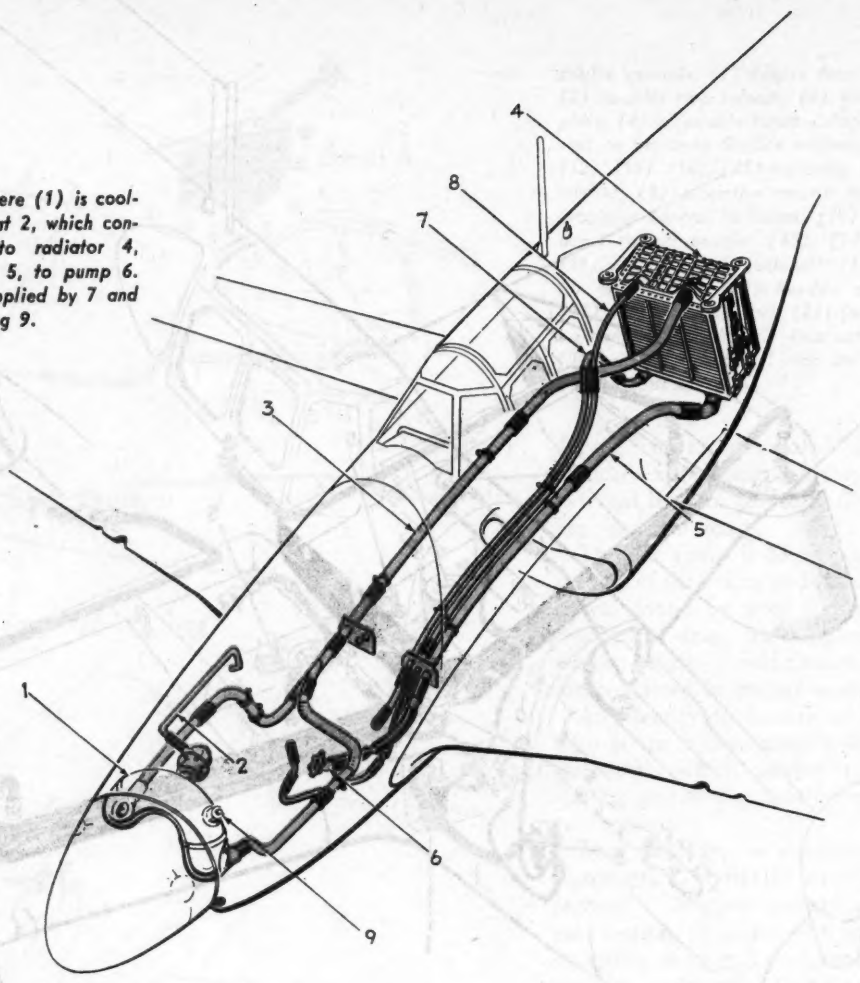


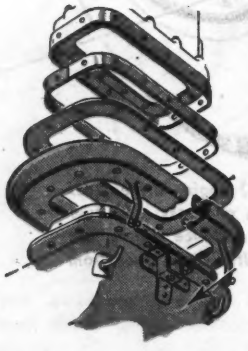
Fuel system. (1) Fuel strainer; (2) Parker primer pump; (3) engine driven fuel pump; (4) selector valve with handle; (5) booster pumps on tanks; (6) fuel gages. Outer streamlined tanks, used for ferrying or long distance flights, are droppable via the bomb release. Primer, operated manually, draws fuel from strainer and injects it directly into engine.

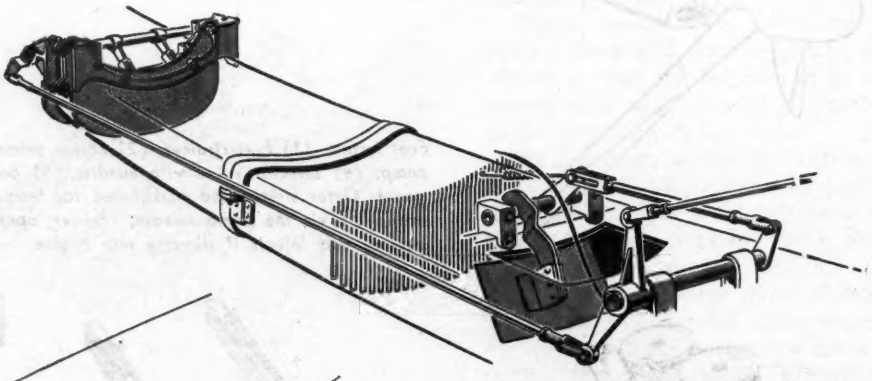


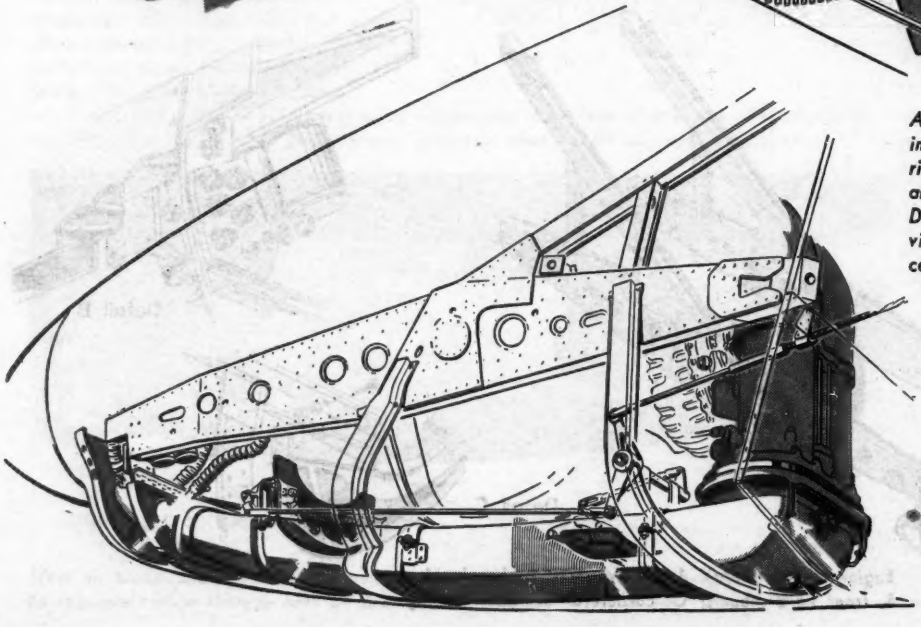
Engine mount. Detail A is Lord shear rubber bushing; B. front Lord mounts; C. carburetor air inlet casting.

Engine coolant system. Here (1) is coolant header tank, vented at 2, which connects through pipe 3 to radiator 4, returning liquid by pipe 5, to pump 6. Supercharger cooler is supplied by 7 and 8. System is filled at plug 9.

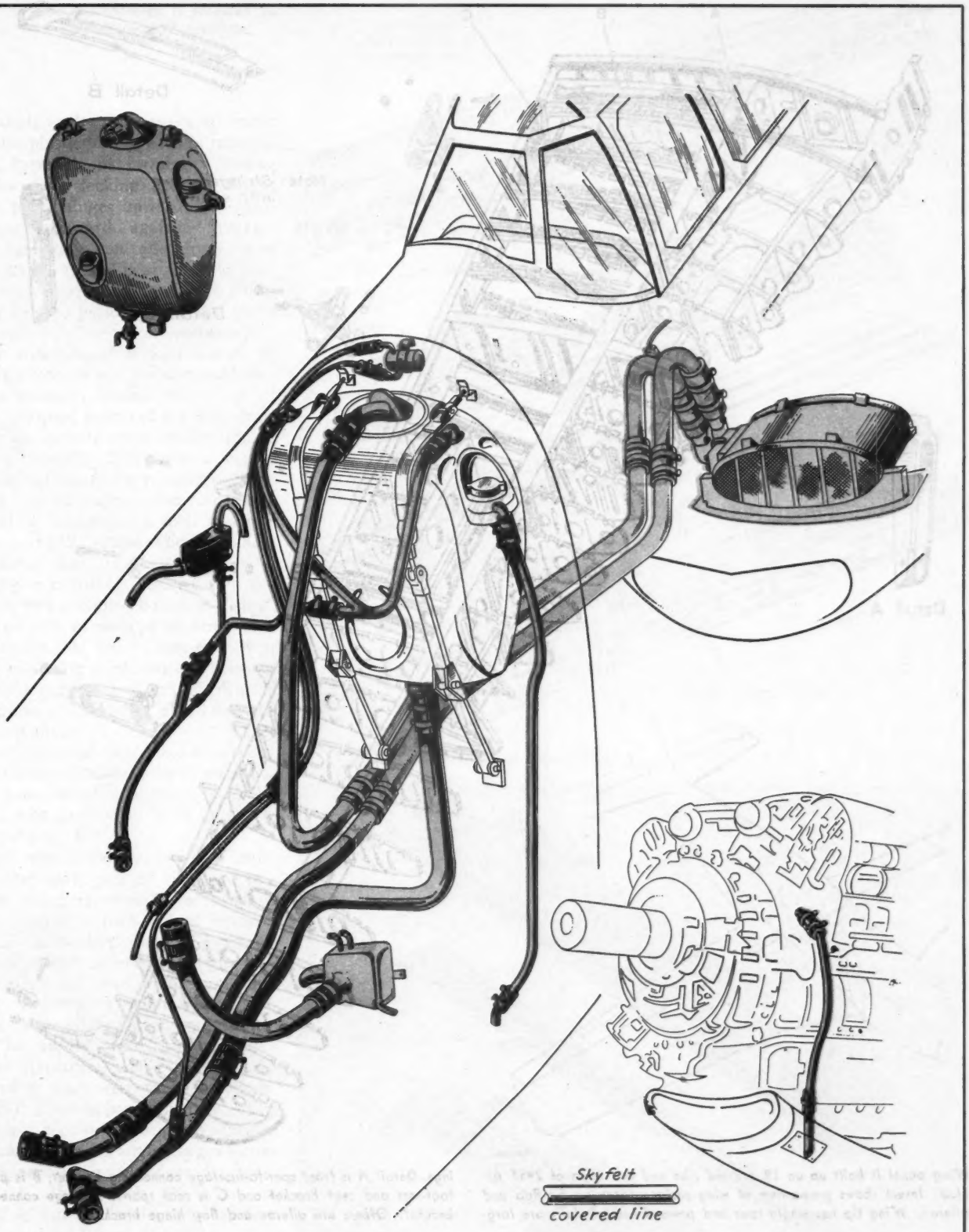




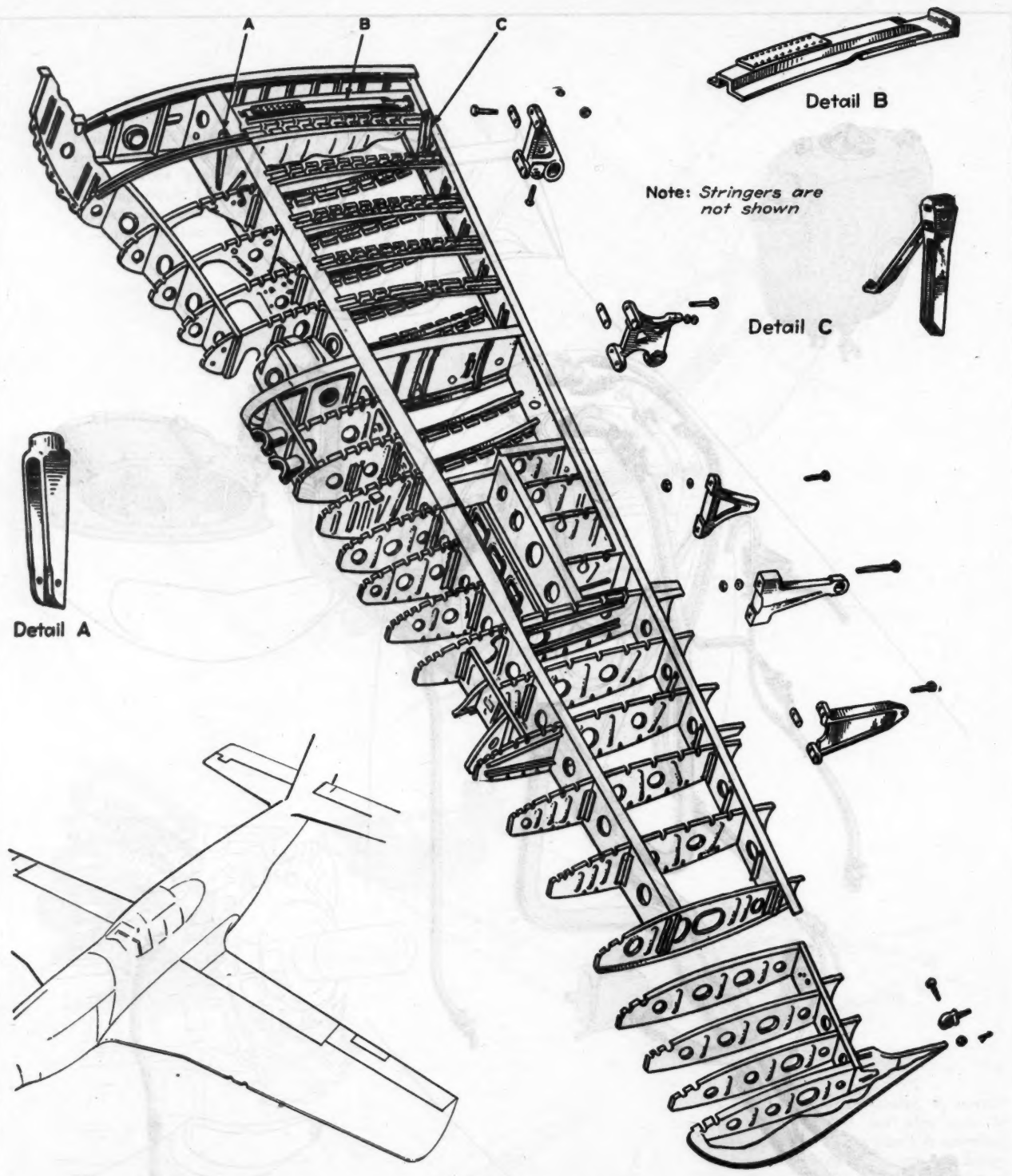




Air ram scoop for carburetor. By operating shutter at left and blast gate at right, pilot can regulate both temperature and pressure of air going into carburetor. Detail (upper left) shows construction of vibration-absorbing connection to base of carburetor.



Oil system showing hopper tank at center with dilution solenoid above and radiator at rear. Oil leaves engine by upper of two pipes (lower left), going directly to radiator, thence to top of tank, through hopper in tank, and back to engine oil pump through large pipe from bottom of tank. Small pipe leading into delivery pipe at lower left is for oil dilution.



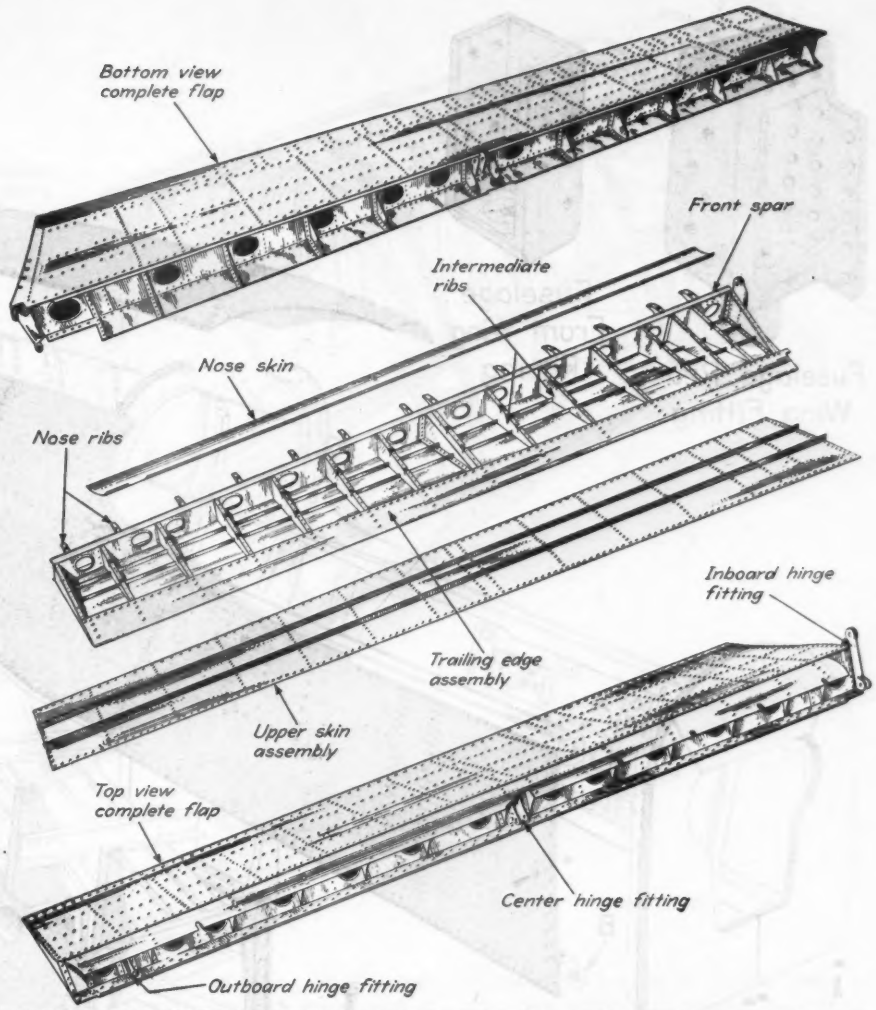
Wing panel is built up on 19 pressed ribs and two spars of 24ST Alclad. Insert shows proportion of wing surface taken up by flap and aileron. Wing tip has single spar and pressed end. Details are forgings. Detail A is front spar-to-fuselage connecting bracket; B is pilot's foot-rest and seat bracket and C is rear spar-to-fuselage connecting bracket. Others are aileron and flap hinge brackets.

The combination armor-plate firewall protects the pilot both against projectiles from line of level flight to approximately 20 deg. below it, also against fire from engine. Firewall is face-hardened steel armor, except a section at center of stainless steel to provide room for oil tank. Aft protection is provided by two plates of face-hardened steel behind the seat.

Protection and visibility are afforded by windshield, rear window, and cockpit enclosure. Forward flat section of windshield is bullet-proof, 5-ply laminated glass, 1½ in. thick, slanted 31 deg. from vertical, being the best compromise for visibility, protection, and aerodynamic contouring. Side and upper panels of windshield are of ⅜-in. safety plate and transparent plastic. Windshield cowling extends from lower forward end of glass to firewall and down to upper longeron.

Over instrument panel a shroud, integral with windshield, extends aft with a circular rubber extrusion to protect pilot. This shroud supports windshield defroster, optical gun sight, and handholds, and it also eliminates instrument glare in windshield glass.

Flaps are made of 24ST with Alclad skin. Stiffness is provided by 15 main ribs and 13 nose ribs.



Cockpit enclosure consists of upper and side plastic panels, each in two sections, forward one forming a sliding window with locking handle. Right upper panel hinges upward; left panel hinges downward against fuselage. Both have locks controlled from inside and outside. Hood is attached by four hinges on upper longerons. An emergency release permits enclosure to be removed or jettisoned in emergency.

Aft windows of molded Lucite fit fuselage contour and are removable for access to radio behind pilot. Aft of radio, plywood bulkhead prevents draft and keeps objects from rolling aft and fouling controls. Nut plates at center of bulkhead secure oxygen bottles.

The rear fuselage section consists of two 24ST longerons, a shelf and five formers of 24ST, three solid bulkheads, and Alclad skin.

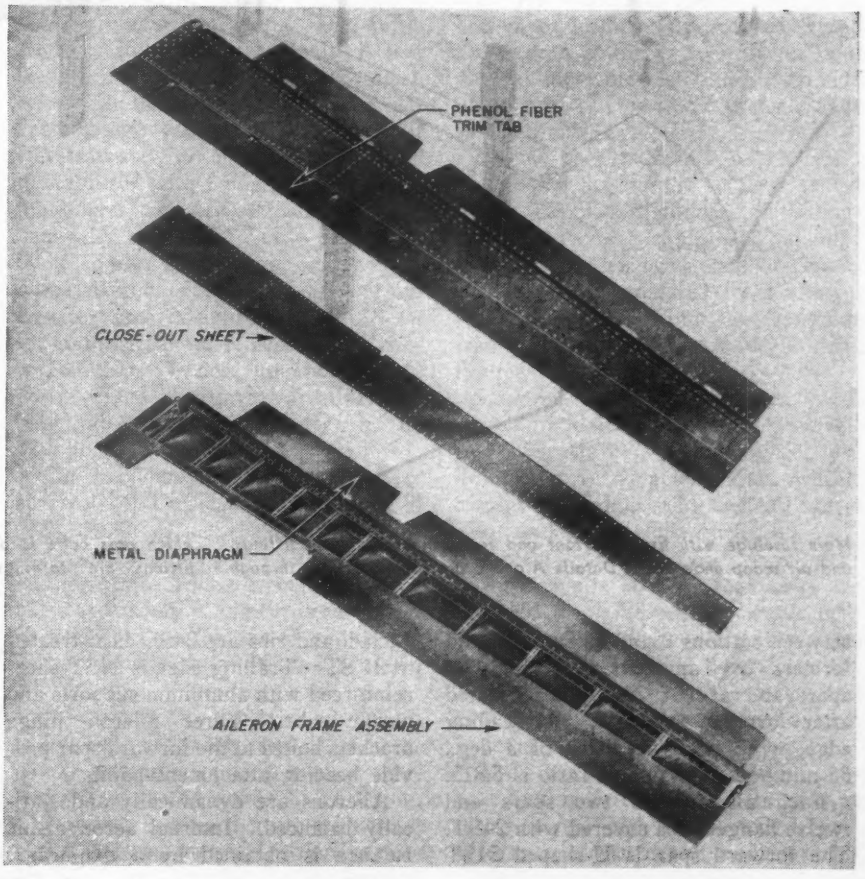
Wing is cantilever stressed-skin design in two sections, bolted at center. Each consists of main panel, removable tip, aileron, and full trailing-edge flap. Wing has angle of incidence of approximately 1 deg. at root and dihedral of 5 deg. along 25 percent chord line, to give stability.

The 25 percent chord line is perpendicular to longitudinal axis of airplane. Wing area, including ailerons, is 233.19 sq. ft., with span of 36 ft. ⅝ in. and a taper ratio of .499.

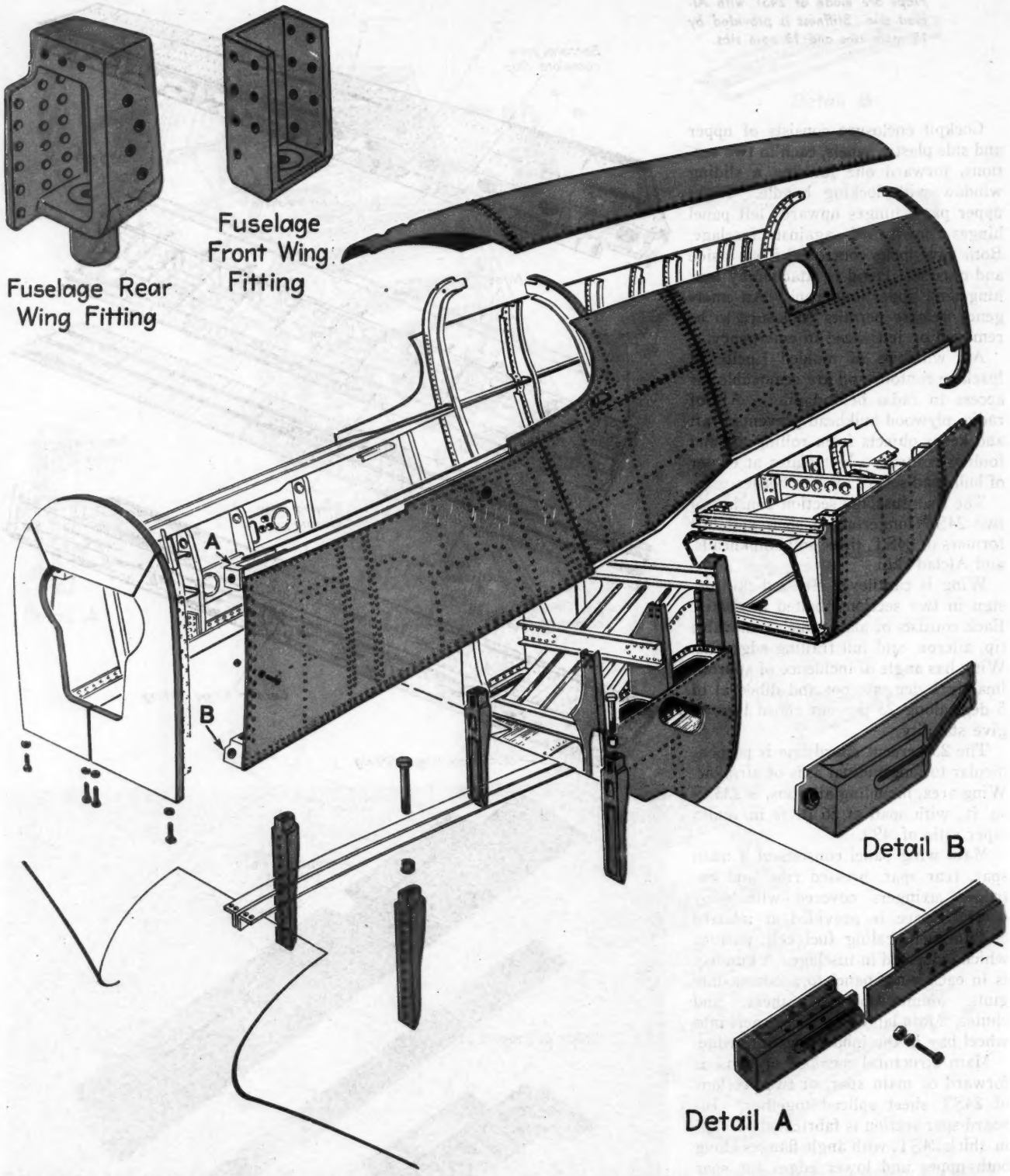
Main wing panel consists of a main spar, rear spar, pressed ribs, and extruded stringers covered with alloy sheet. Space is provided at inboard end for self-sealing fuel cell, part of which is located in fuselage. A gun bay is in each wing panel to accommodate guns, ammunition containers, and chutes. Main landing gear retracts into wheel bay in the inboard leading edge.

Main structural member of wing is forward or main spar, of two sections of 24ST sheet spliced together. Inboard spar section is fabricated of .129-in. thick 24ST, with angle flanges along both upper and lower edges for spar caps. A .25-in. thick 24ST bar is riveted to inner side of upper cap between stations 0 and 85.5.

Rear spar is formed of two sheets of 24ST spliced at station 128.6. Upper cap is reinforced by a .091 24SO angle



Ailerons are built of 24ST with plastic tab. A metal diaphragm retains aerodynamic smoothness at joint with wing.



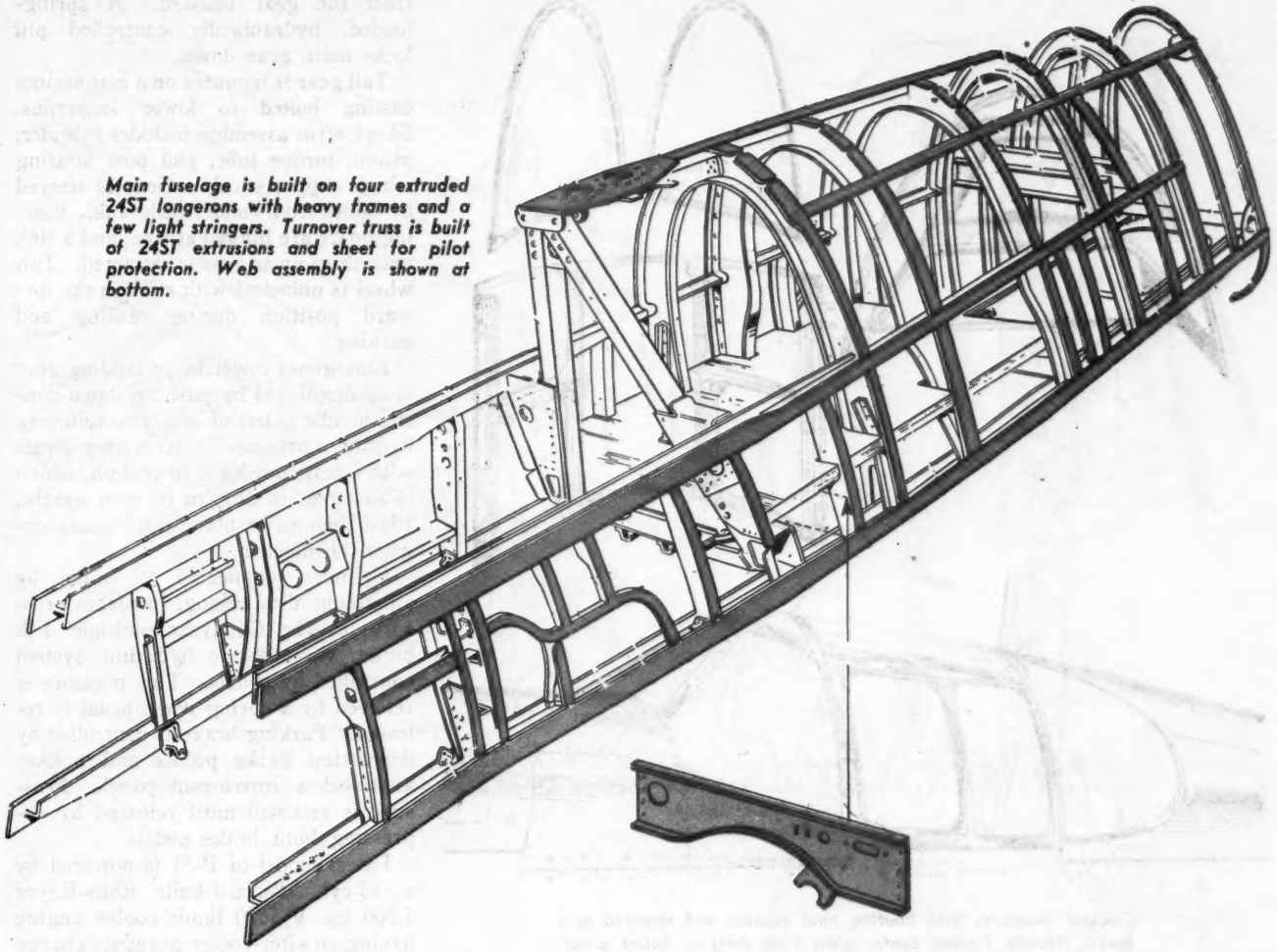
Main fuselage with firewall, front and rear wing attachment fittings, and air scoop underneath. Details A and B are forged fittings through which pass bolts holding engine mount and firewall. Fuselage wing fittings are forgings carrying bolts for attachment of wings.

between stations 0 and 92.5. Ribs and formers are approximately 12.5 in. apart and are of 24SO, heat-treated after forming to 24ST. At leading edge, wing has sweepback of 3 deg., 35 min., 32 sec. Aspect ratio is 5.815.

Each aileron has two spars and twelve flanged ribs covered with 24ST. The forward spar is U-shaped 24ST Alclad, and ribs are 24SO heat-treated to 24 ST. Trailing edge is 24ST sheet reinforced with aluminum supports and plastic ribs. Three aileron hinge brackets bolted to the forward spar provide bearing attachment points.

Ailerons are dynamically and statically balanced. Internal aerodynamic balance is obtained by a diaphragm attached to forward edge of aileron and sealed to the rear spar by fabric strip.

Phenol-fiber trim tabs are mounted in each aileron by three hinge bearings. A metal horn tab provides attachment for actuating rod. Left tab, adjustable in flight, is operated by knob on control pedestal. Angular travel, 10



Main fuselage is built on four extruded 24ST longerons with heavy frames and a few light stringers. Turnover truss is built of 24ST extrusions and sheet for pilot protection. Web assembly is shown at bottom.

deg. up and 10 deg. down, is limited by stops on cables.

Ailerons are conventionally controlled by the stick, and to meet variations in specifications they can be connected for angular travel of 10, 12, or 15 deg.

Structure of the 24ST Alclad-covered wing flaps is two Alclad spars, 13 nose ribs of 24SO heat-treated after forming to 24ST, 15 main ribs, and a series of rolled-section stringers, all of 24 ST. The flap trailing edge is formed from a single 24ST sheet reinforced with 27 tapered hat-section supports. The flaps are hinged on three sealed ball bearings, and are hydraulically controlled by a lever on the control pedestal. Position of lever selects and holds any corresponding position of the flaps.

Stabilizer is full cantilever, nonadjustable, with detachable tips, and is fixed at a positive 2-deg. angle of incidence relative to the longitudinal axis of the airplane. Forward and aft spars are of 24ST Alclad. Flanged ribs are formed of 24 SO Alclad heat-treated to 24ST, as are six extruded stringers. Dual stringers are on the lower covering. Stabilizer tips are of 52S, ½H stock on two ribs. Area is approximately 28 sq. ft., and span is 13 ft. 2⅛ in.

Elevator incorporates 18 flanged ribs, front spar, trailing edge, and a short intercostal beam, all 24ST Alclad. Covering is fabric with Alclad leading edge extending to main spar, except for that portion cut out for elevator hinge fitting. Right and left elevators are interchangeable, fastened to stabilizer with five sealed ball bearing hinges, and are statically and dynamically balanced. Static balance is by a 13¼-lb. lead weight attached to outboard end of leading edge. Total elevator area is approximately 13 sq. ft., and angular movement by the control stick is 30 deg. up and 20 deg. down. Each elevator has an adjustable trim tab approximately 4$\frac{11}{32}$ in. by 32$\frac{7}{16}$ in.

Fin is composed of front and rear spars of 24ST Alclad and ribs covered with 24ST Alclad sheet. Tip is on two ribs, and skin is stiffened spanwise by light rolled stringers. Area of fin is 9.61 sq. ft., and it is set 1 deg. to the left of center line of rear beam.

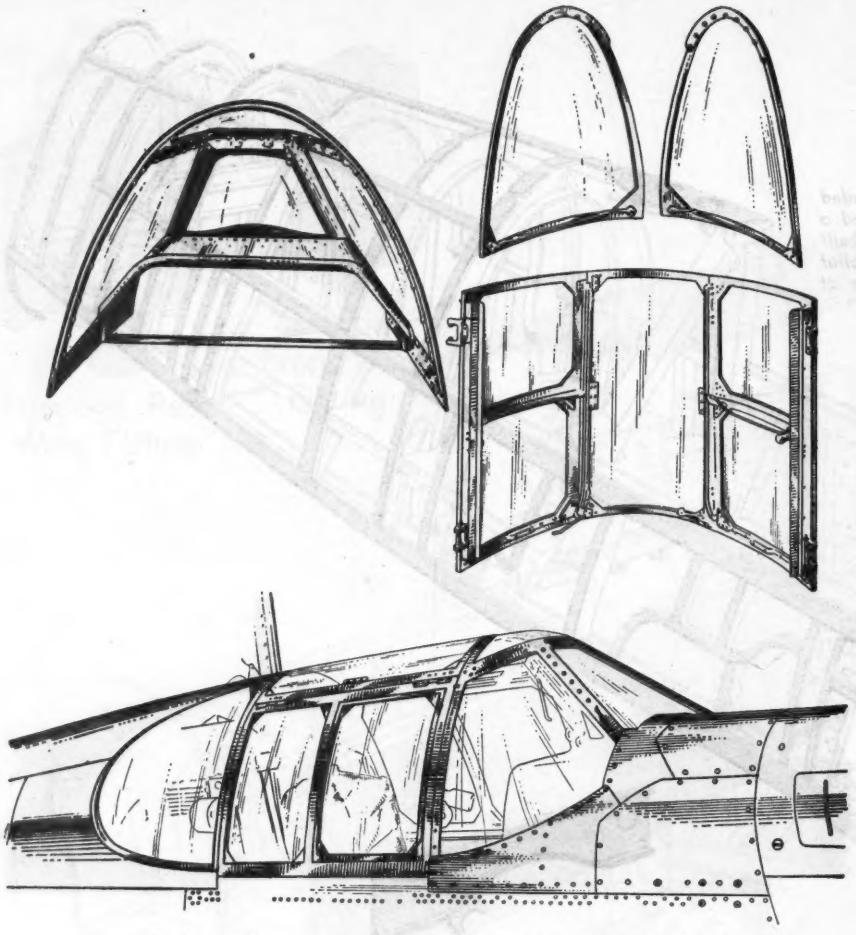
Rudder consists of spar, 20 flanged Alclad ribs, V trailing edge, and a short beam in front of trim tab, which is covered with fabric, and 24ST sheet covers leading edge back to main spar, except cut-out for rudder hinge fitting. The rudder is hinged to fin with three sealed ball bearings and is dynamically balanced by means of 16.6-lb. lead at top. An additional balance weight at bottom of leading edge reduces static unbalance. Area is 10.4 sq. ft., and angular movement is 30 deg. each side of neutral. Operation is by pedals through cables.

Phenol-fiber trim tabs on elevators and rudder are hinged by three sealed needle bearings. Rudder tab is controllable from cockpit, and angular travel is 10 deg. each side of center. Elevator tabs, operated by a control wheel on left of cockpit, have angular travel 10 deg. up and 25 deg. down, limited by stops on cable.

Landing gear is three-point, with two 27-in. main wheels and full-swiveling, steerable 12.5 in. tail wheel, hydraulically retractable. Main wheels retract into wing wells and tail wheel into fuselage, all fully enclosed.

Except for hydraulic main gear down-lock pin, landing gear locks are actuated from the control handle bellcrank. Cables from bellcrank actuate tail gear up-latch and down-lock pin. A push-pull rod from the lower end of the control handle works lock system in main wheel bay.

Main landing gear magnesium support casting is bolted to front spar at the outboard end of the wheel well. Hydraulic struts on the front spar re-



Cockpit inclosure, with floating back cushion and armored seat back. Heavily framed center glass (top left) is bullet proof.

tract the gear inboard. A spring-loaded, hydraulically controlled pin locks main gear down.

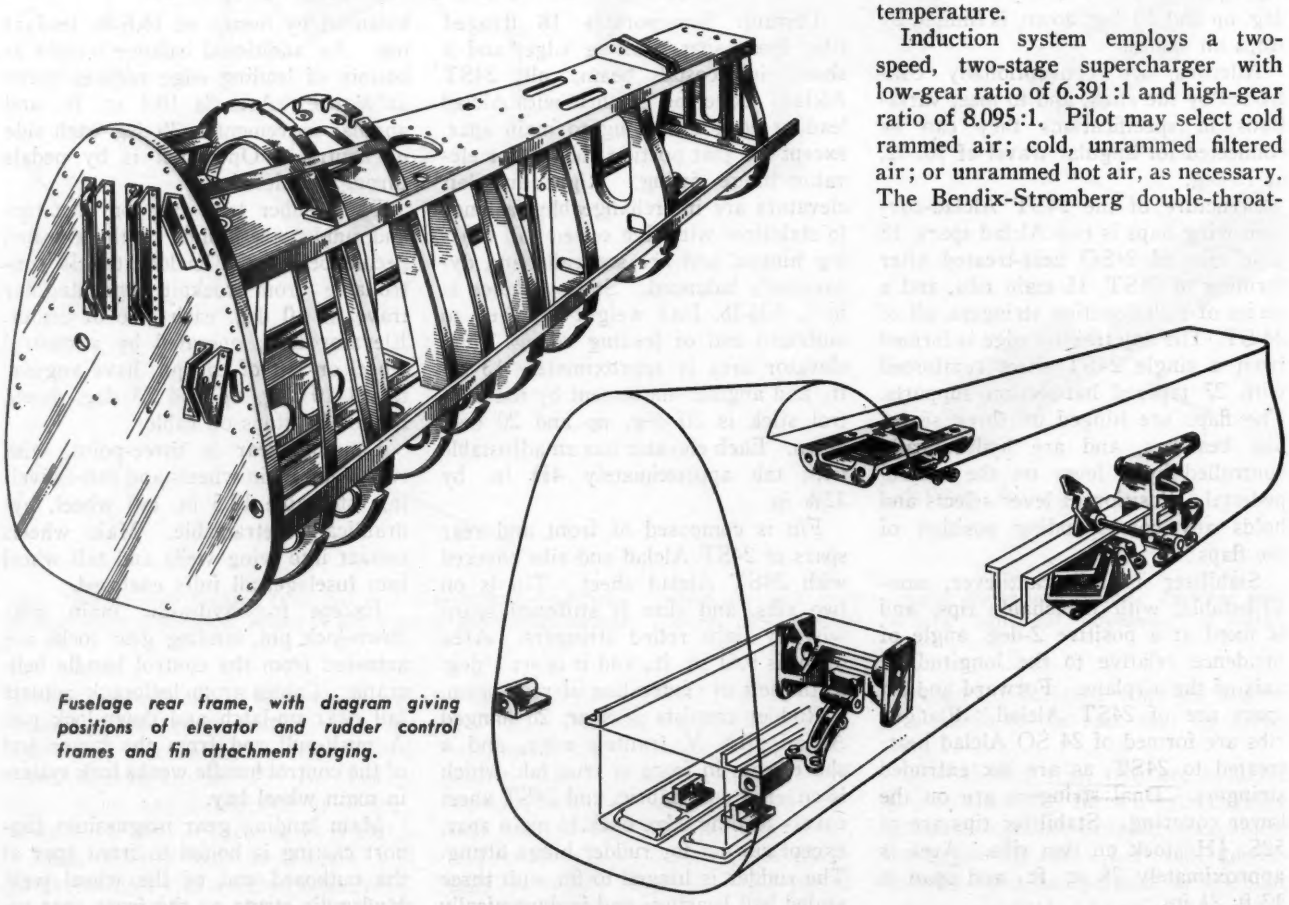
Tail gear is mounted on a magnesium casting bolted to lower longerons. Shock strut assembly includes cylinder, piston, torque tube, and post housing which supports axle. Gear is steered by cables from rudder bellcrank. Fairing doors are hinged at side, and a link pulls them up as gear is retracted. Tail wheel is unlocked with stick in the forward position during taxiing and parking.

Emergency lowering of landing gear is accomplished by pushing down control handle at left of seat, also relieving hydraulic pressure in retracting struts with emergency knob in cockpit, which causes gear to drop of its own weight. Pilot then yaws plane until gears engage downlocks.

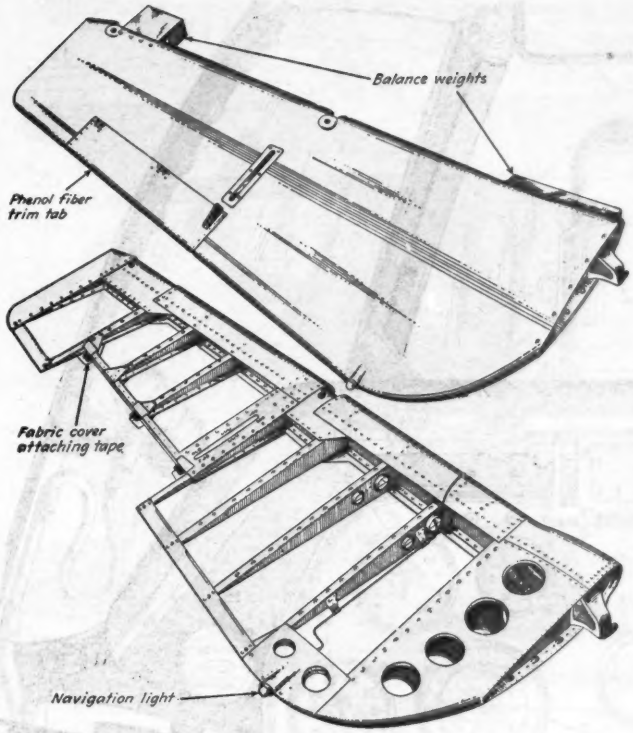
Cylinder, connected to brake by aluminum alloy tubing, furnishes pressure for the Goodyear multiple disk brake, via separate hydraulic system controlled by pedals. This pressure is relieved by a spring when pedal is released. Parking brake is controlled by depressing brake pedals and pulling knob below instrument panel. Pressure is retained until released by depressing both brake pedals.

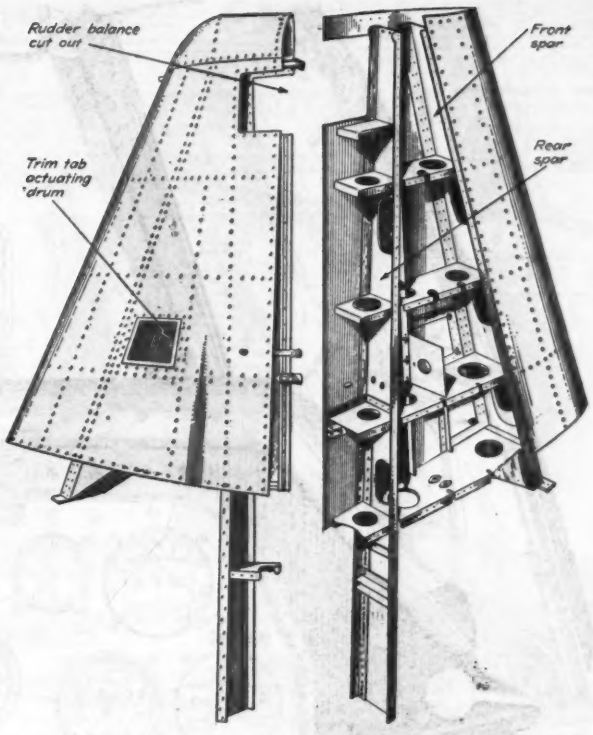
Latest model of P-51 is powered by a 12-cyl. Packard-built Rolls-Royce 1,500 hp. V-1650 liquid-cooled engine having an after-cooler to reduce charge temperature.

Induction system employs a two-speed, two-stage supercharger with low-gear ratio of 6.391:1 and high-gear ratio of 8.095:1. Pilot may select cold rammed air; cold, unrammed filtered air; or unrammed hot air, as necessary. The Bendix-Stromberg double-throat-

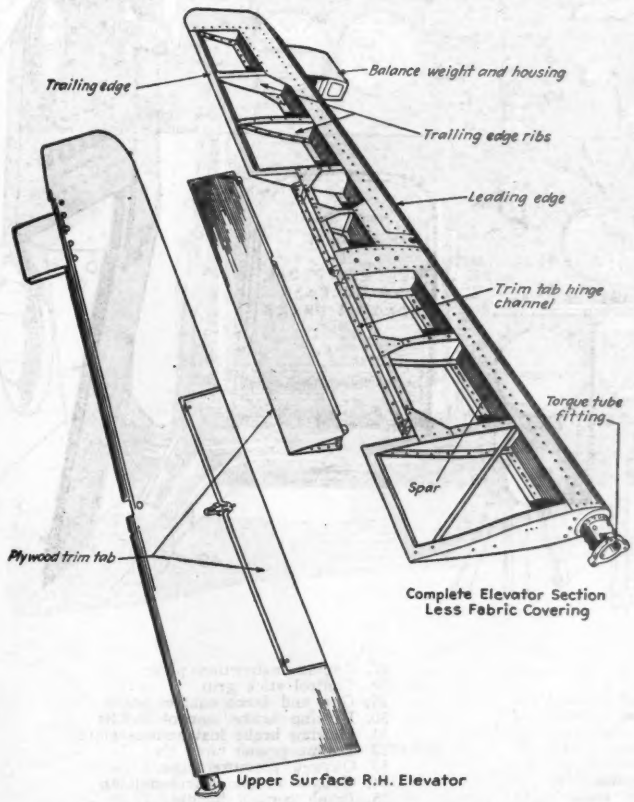


Fuselage rear frame, with diagram giving positions of elevator and rudder control frames and fin attachment forging.

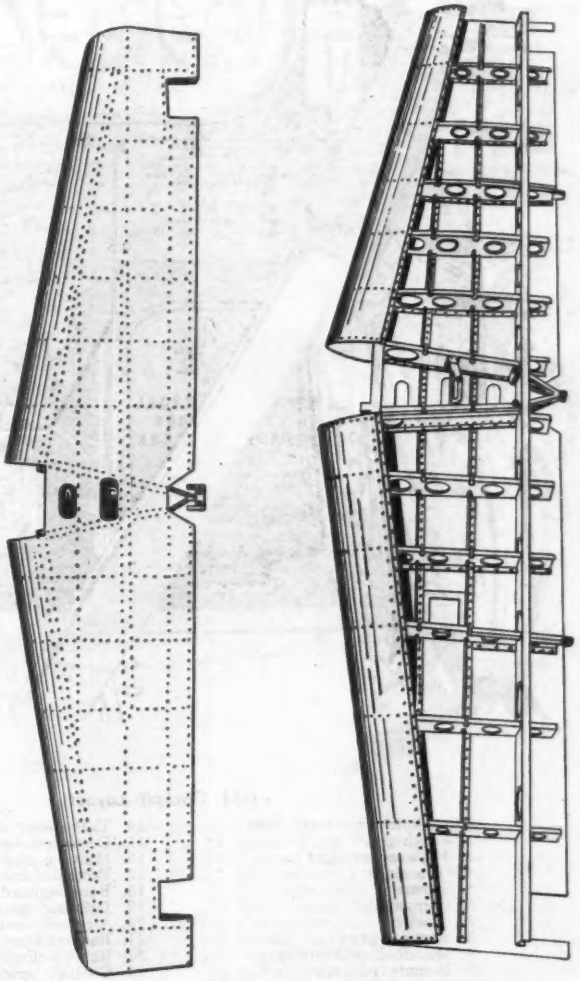




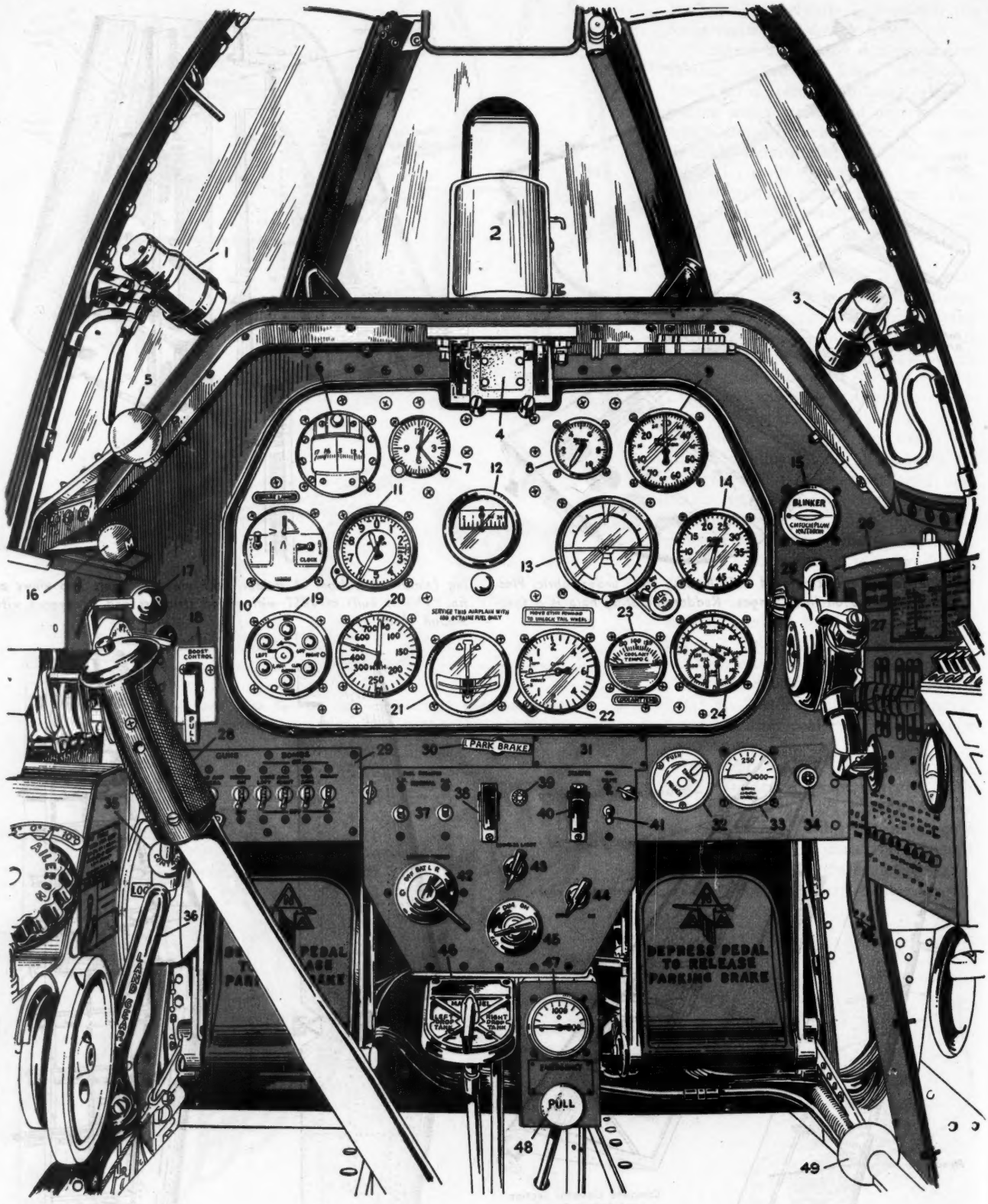
Left: Rudder is fabric-covered 24ST leading edge under fabric. Plastic tab is carried on three hinges. Rudder-operating horn is a forging (shown at bottom of rudder, both views). Right: Two views of fin. This is built of 24ST with rolled stringers and is covered with Alclad sheet.



Elevator is built of 24ST frame with fabric covering. Leading edge is 24ST under fabric. Trim tab, made of plywood, is operated by horn near center. Balance weights are concealed in stabilizer. Elevator control is through 3-bolt coupling at inside end.

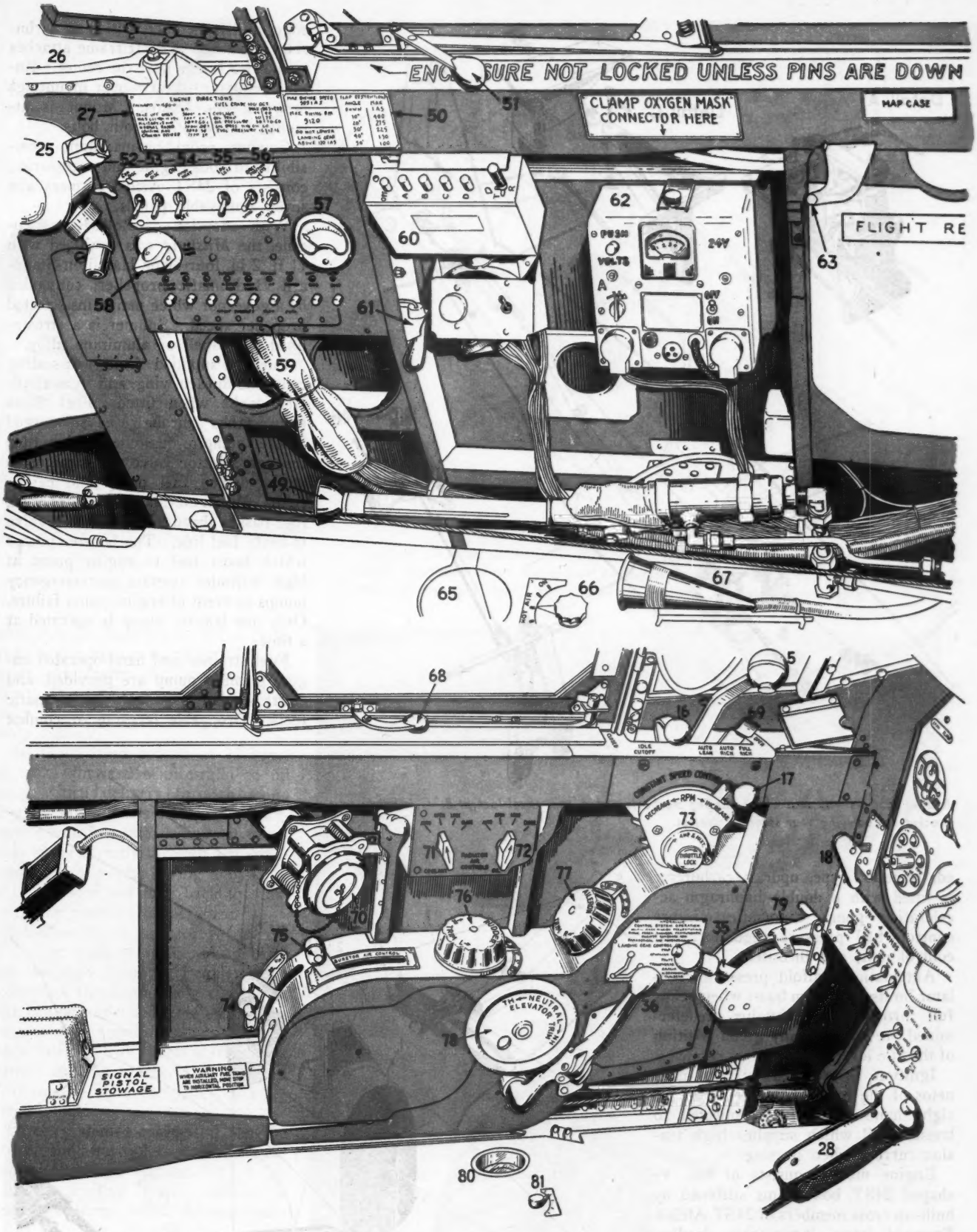


Stabilizer is full cantilever type with Alclad frame and covering. Half-hard 52S is used for the tips, built on two ribs.

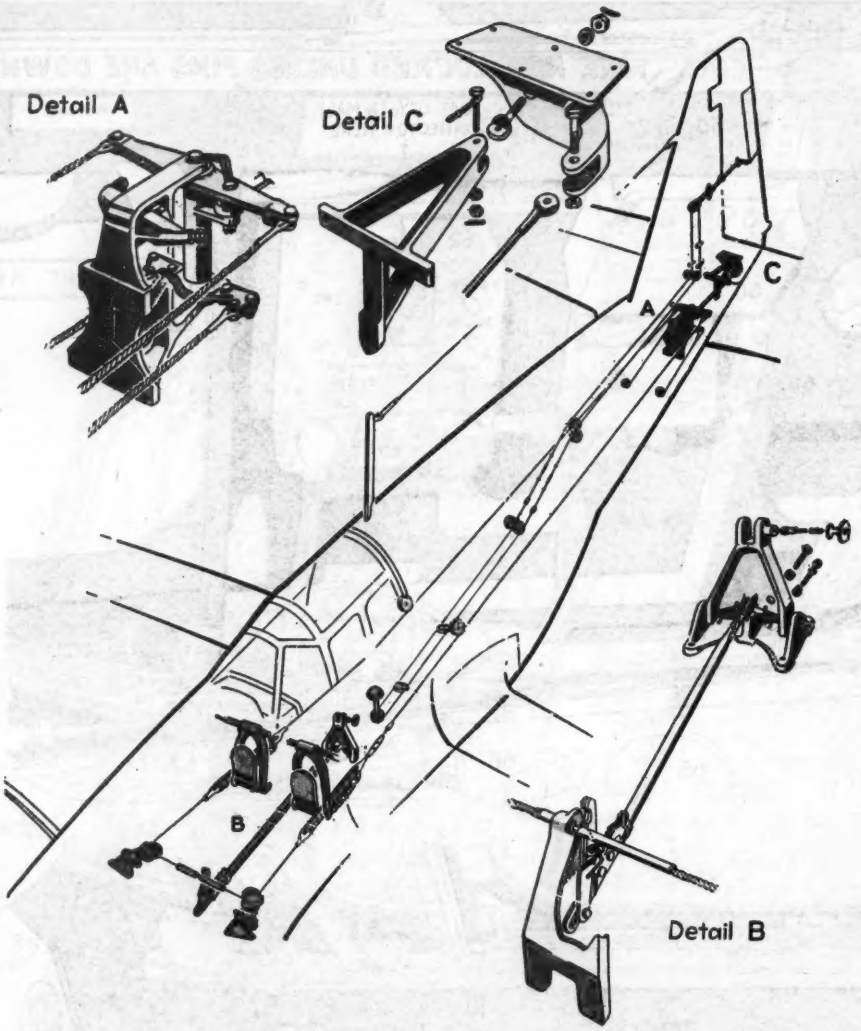


P-51 Cockpit Layout

1. Cockpit fluorescent light
2. Crash pad
3. Fluorescent light
4. Gun sight
5. Throttle
6. Compass
7. Clock
8. Suction gage
9. Manifold pressure gage
10. Remote contactor
11. Altimeter
12. Directional gyro
13. Flight indicator
14. Tachometer
15. Oxygen flow blinker
16. Mixture control
17. Propeller control
18. Boost control
19. Landing gear indicator
20. Airspeed indicator
21. Bank-and-turn indicator
22. Rate-of-climb indicator
23. Coolant temperature indicator
24. Oil temperature and fuel and oil gage
25. Oxygen regulator
26. Enclosure for emergency release handle
27. Engine instruction plate
28. Control stick grip
29. Gun and bomb control panel
30. Parking brake control handle
31. Parking brake instructions plate
32. Engine primer
33. Oxygen pressure gage
34. Oxygen system warning lamp
35. Bomb control handle
36. Landing gear controls
37. Booster pump switches
38. Supercharger control
39. Supercharger warning light
40. Starter switch
41. Oil dilution switch



42. Ignition switch
43. Compass light control
44. Gun sight light control
45. Left hand fluorescent light control
46. Fuel valve control
47. Hydraulic pressure gage
48. Emergency fairing door control
49. Hydraulic hand pump
50. Airplane restriction plate (top)
51. Cockpit enclosure handle
52. Generator-disconnect switch
53. Battery-disconnect switch
54. Pitot heater switch
55. Landing light switch
56. Position light switches
57. Ammeter
58. RH fluorescent light control
59. Circuit-breaker buttons
60. SCR-522 radio control box
61. Cockpit light
62. SCR-535 radio control box
63. Map case
64. (Restricted)
65. Right fuel tank gage
66. Hot air control
67. Pilot's relief tube
68. Sliding window lock handle (below)
69. Carburetor mixture control
70. Signal pistol discharge tube
71. Coolant radiator scoop control
72. Oil radiator scoop control
73. Quadrant friction control
74. Flap control handle
75. Carburetor air control
76. Rudder trim tab control
77. Aileron trim tab control
78. Elevator trim tab control
79. Bomb control anti-salvo guard
80. Left fuel tank gage
81. Defroster control



Rudder controls with rear wheel steering mechanism at A and wheel lock at B. C is heavy rear bracket for carrying rear steering stresses.

ed, injection type, updraft carburetor is fitted with a double-diaphragm acceleration pump, automatic mixture control, fuel pressure regulator, fuel control unit, and throttle.

Automatic manifold pressure regulator limits maximum boost when below full throttle and maintains predetermined pressure for any given position of throttle lever.

Ignition is provided by two magnetos of the rotating magnet type, the right hand one being connected to booster coil which supplies high tension current when starting.

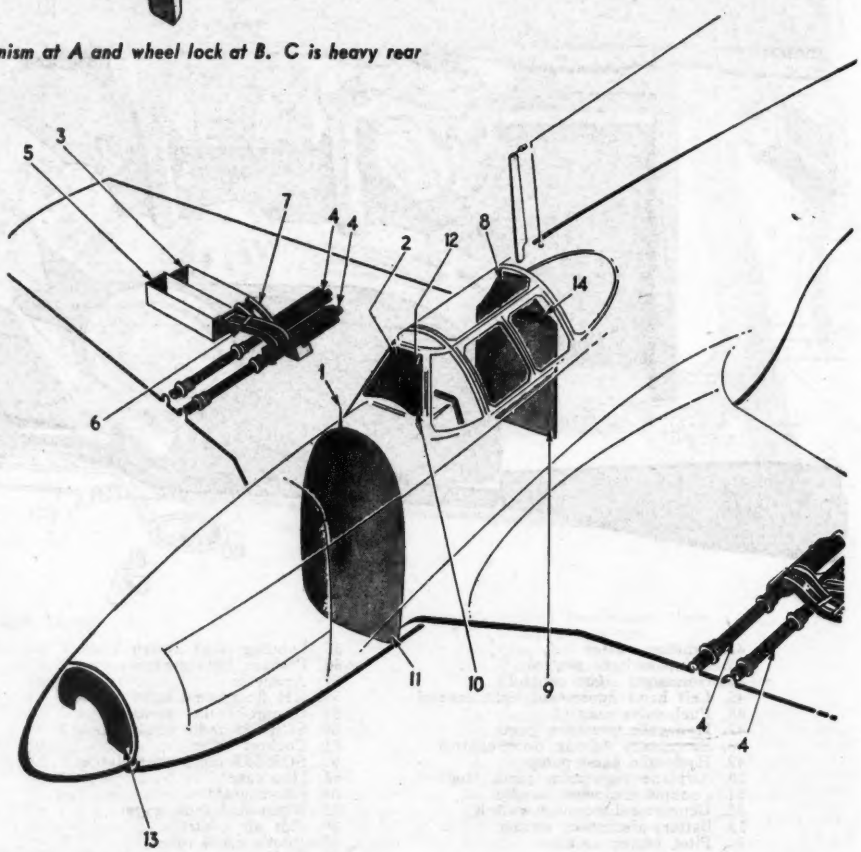
Engine mount consists of two Y-shaped 24ST box beams stiffened by built-up cross members of 24ST Alclad. Forward frame incorporates leading edge, and front duct section of carburetor air scoop and aft frame attaches to the two beams near the center. Engine is supported on rubber mountings between side beams. Mount is attached to firewall by four bolts.

Cowling, providing maximum accessibility to both engine and accessories, consists of 24ST Alclad formers and seven removable panels.

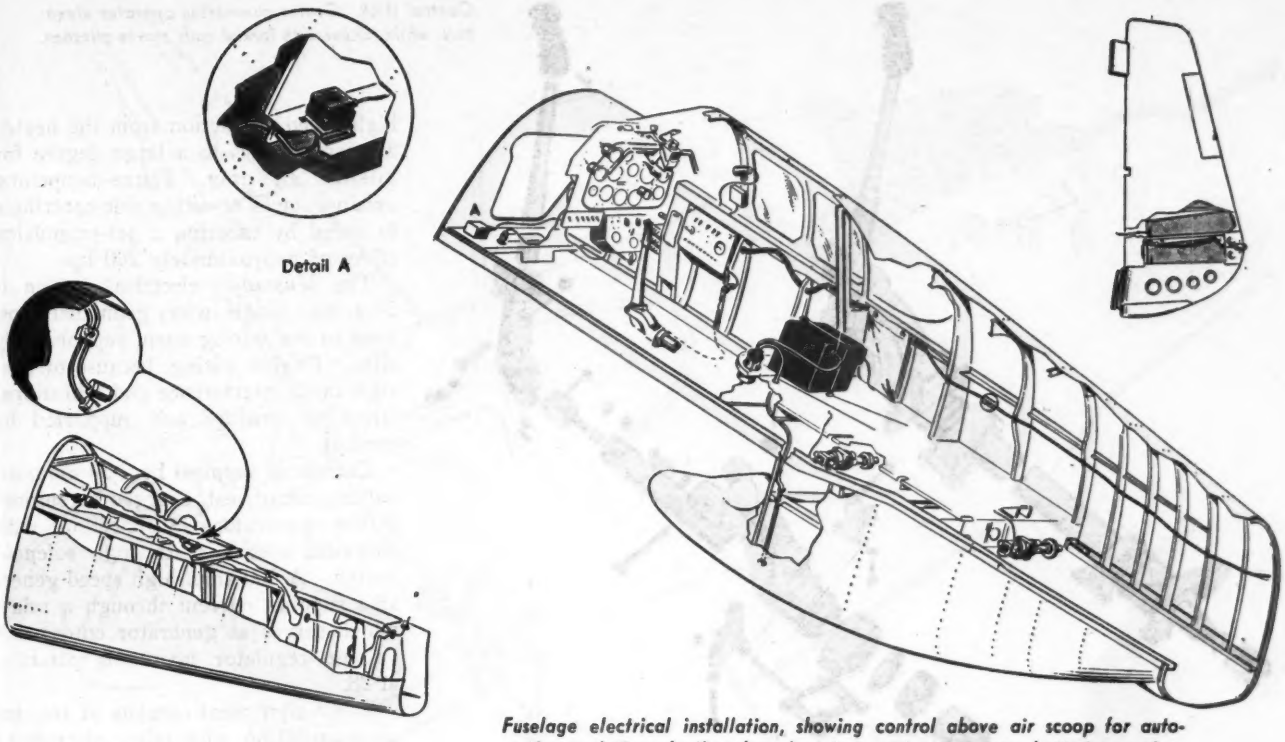
With adoption of Rolls-Royce engine, the *Mustang* was equipped with 11 ft. 2 in. four-blade Hamilton Standard Hydromatic propeller, controlled by a governor which maintains selected propeller speed. Spinner is a streamlined spun-shell of aluminum alloy.

Fuel is supplied from self-sealing cells, one in each wing, and from auxiliary tanks when fitted. Fuel flows from tanks through a submerged booster pump to dual check valve, then through selector valve and strainer to engine-driven fuel pump and carburetor. When auxiliary tanks are used, fuel passes through the selector valve to main fuel line. The booster pumps which boost fuel to engine pump at high altitudes operate as emergency pumps in event of engine-pump failure. Only one booster pump is operated at a time.

Fuel strainer and hand-operated engine priming pump are provided, and entire system is suitable for aromatic fuels. Droppable ferrying or combat



Guns and armor. (1) & (2) Ring sights; (3) & (5) ammunition boxes; (4) machine guns; (6) & (7) ammunition chutes; (8), (9), (11) & (13) armor plate; (10) bullet-proof windshield; (12) optical gun sight; (14) detachable Plexiglas side panels.



Fuselage electrical installation, showing control above air scoop for automatic regulation of oil and coolant temperatures, storage batteries, navigation light (upper right) and (detail A) methods of making connections.

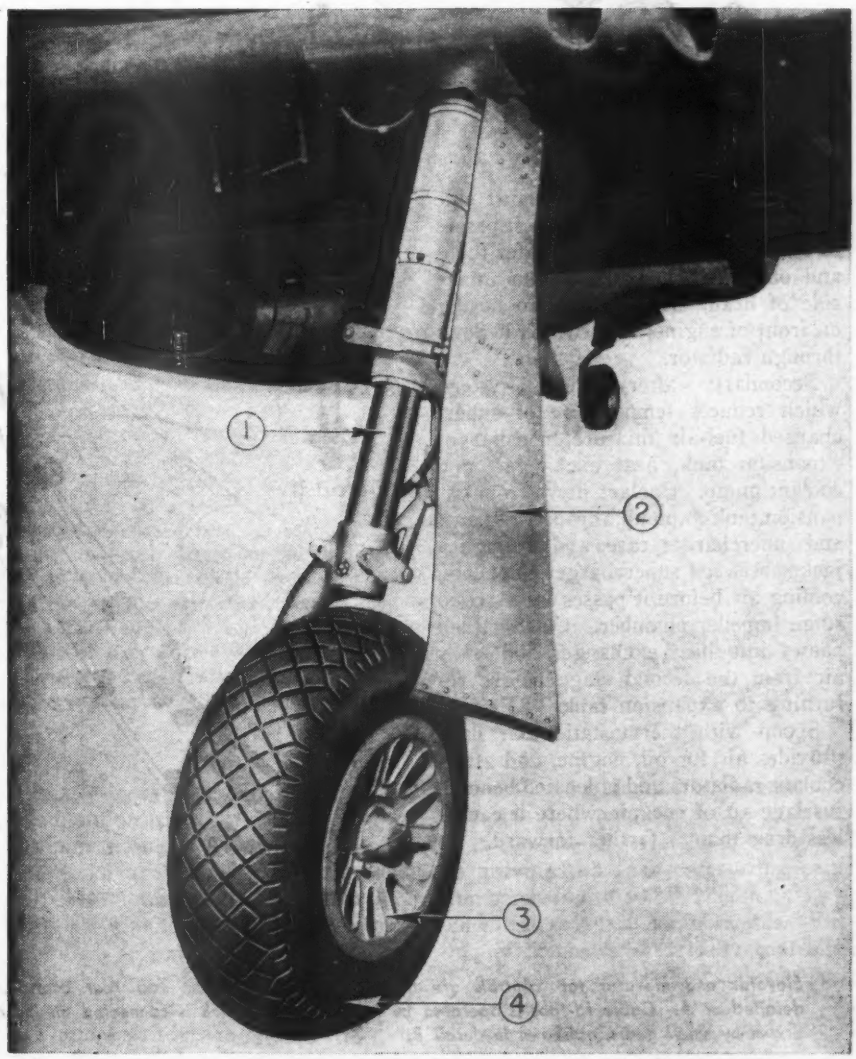
tanks may be installed on bomb racks when bombs are not being carried, fuel being withdrawn by engine-driven pump. Pressure is supplied to ferrying tanks by connecting them to vacuum pump exhaust.

Oil flows from bottom of 12.3-gal. oil tank (forward of firewall) to oil pump which delivers through Cuno filter to moving parts of engine. Scavenger pump in sump delivers it to oil tank, either directly through a thermostatic control valve, having a by-pass, or to radiator and then back to tank, depending upon oil temperature.

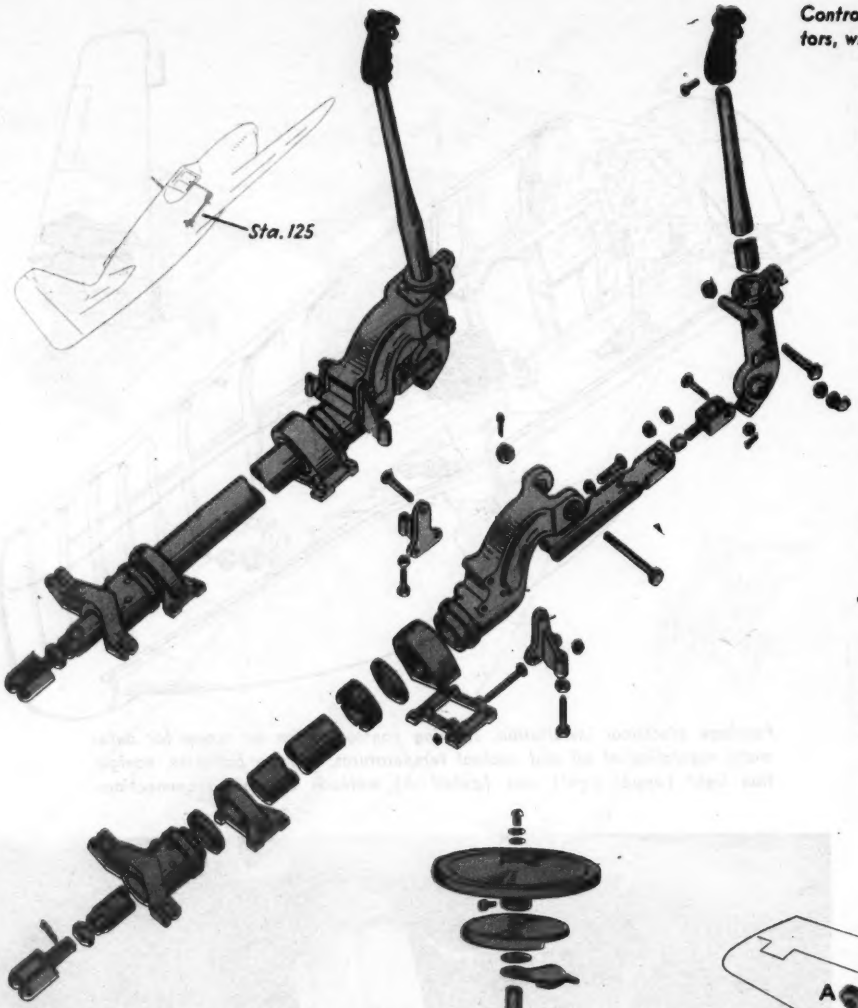
Self-thawing oil radiator is forward of coolant radiator inside scoop. Airflow through scoop is regulated by outlet flap, thermostatically controlled. Flap can be controlled from the cockpit for emergency operation, and a surge valve, integral with thermostatic valve, permits cold oil at excessive pressure to by-pass radiator completely and return to tank.

Three systems—engine oil, engine coolant, and aftercooler—cool the *Mustang's* Rolls-Royce engine.

Engine cooling system utilizes a centrifugal pump which delivers cool-



Left landing wheel of "Mustang". (1) Shock strut; (2) fairing; (3) wheel with dust cap; and (4) 27-in. tire.



Control stick. Center connection operates elevators, while rocker with forked ends moves ailerons.

high speed, jet action from the heated air compensates to a large degree for internal air drag. Flame-dampening exhaust stacks on either side contribute to speed by exerting a jet-propulsion effect of approximately 200 hp.

The *Mustang's* electrical system is 24-v. d.c., single wire, grounded type, most of the wiring open, supported by clips. Engine wiring, because of possible radio interference and vibrational stress, is shielded and supported by conduit.

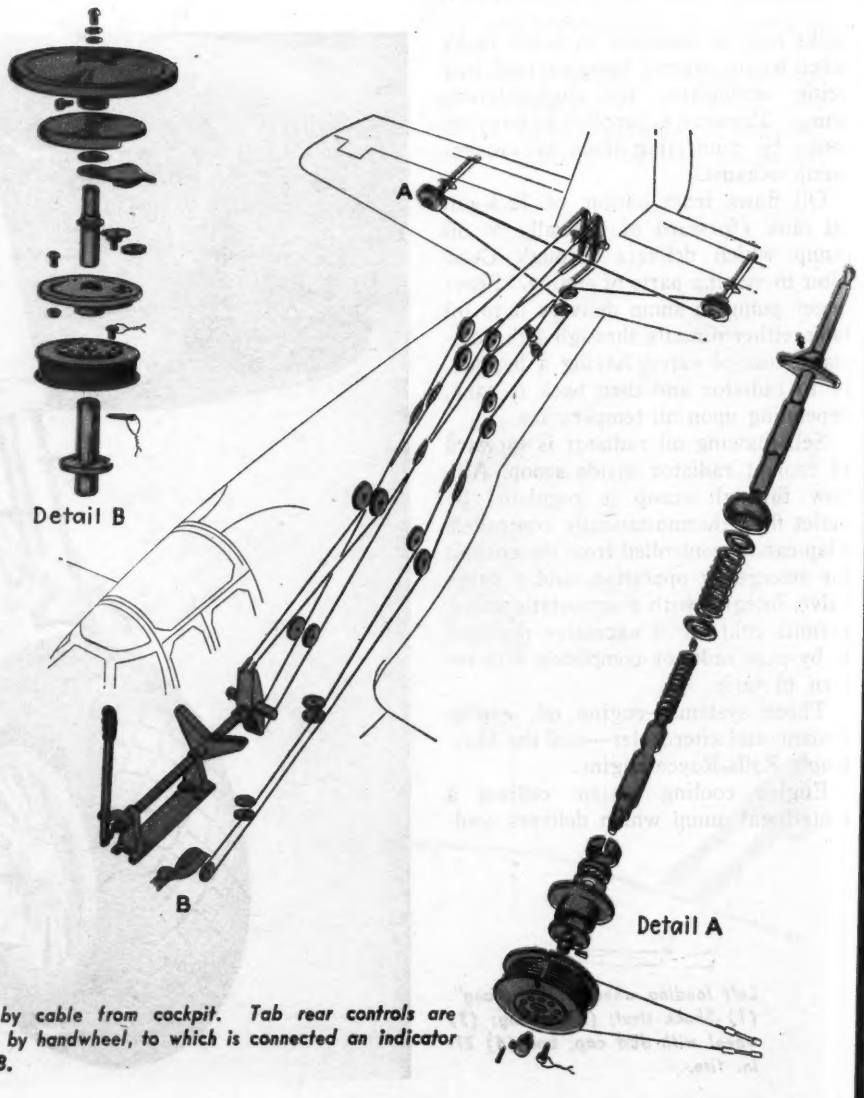
Current is supplied by a 34 amp.-hr. battery, aft of seat, charged by engine-driven generator. Connection with electrical system is through solenoid switch. A 100-amp. high speed generator supplies current through a relay, which serves as generator cutout. A voltage regulator maintains potential at 28.

Radio equipment consists of sets for communication with other aircraft or ground. Antenna is a fore-and-aft,

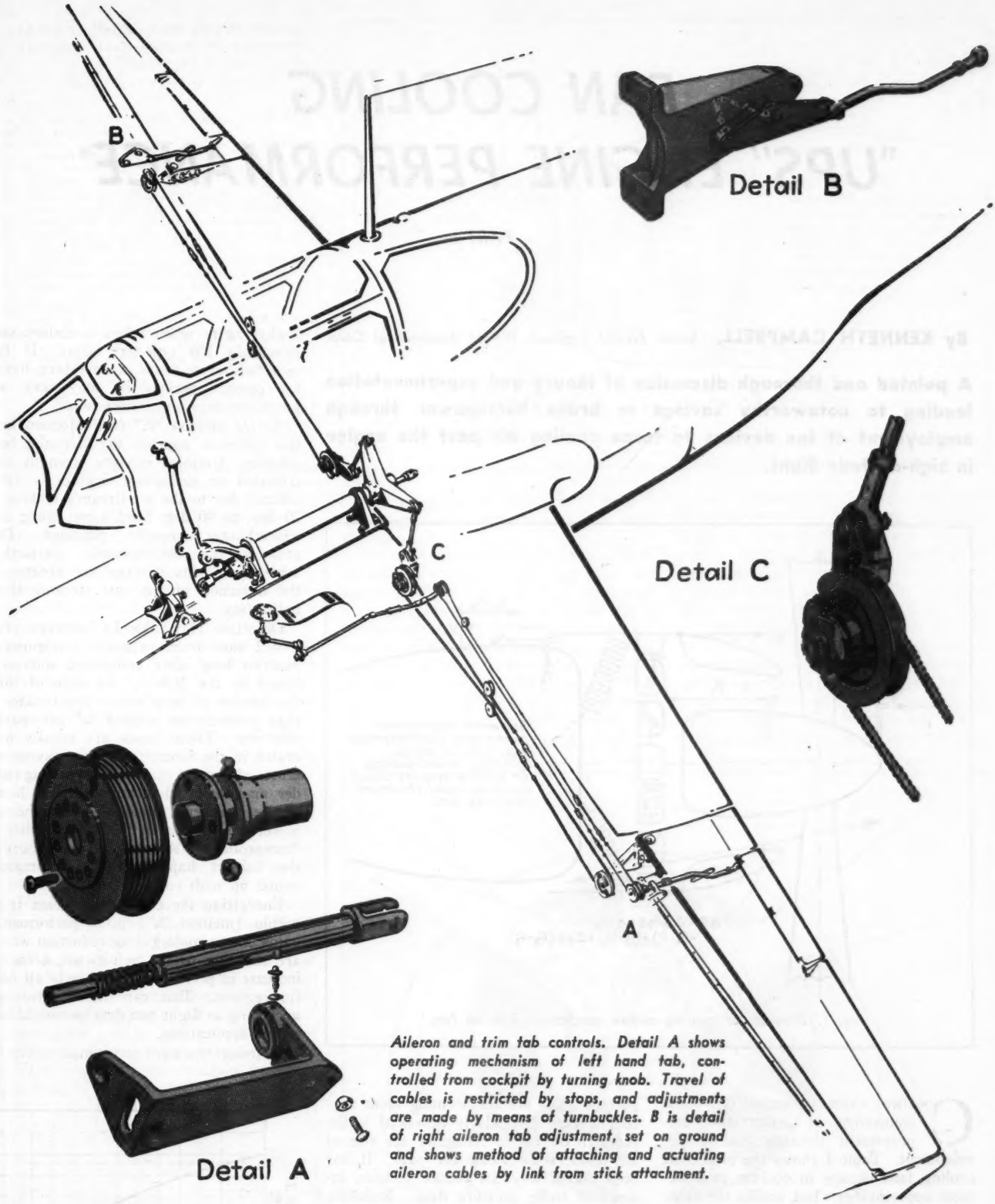
ant into jacket on lower exhaust side of each cylinder block, whence it passes to cylinder head through transfer tubes and out through manifolds on intake side of head, discharging into header on front of engine, from which it flows through radiator.

Secondary after-cooling system, which reduces temperature of supercharged fuel-air mixture, consists of expansion tank, heat exchanger, and coolant pump. Coolant flows from expansion tank to pump, through radiator and supercharger case, and through a jacket between supercharger impellers, cooling air before it passes into second stage impeller chamber. Coolant then passes into heat exchanger and cools air from the second stage before returning to expansion tank.

Scoop with thermostatic exit flaps provides air for oil, engine, and after-coolant radiators and is located beneath fuselage aft of cockpit, where it causes less drag than if farther forward. At



Elevator and elevator tab controls are by cable from cockpit. Tab rear controls are detailed at A. Cable to tabs is operated by handwheel, to which is connected an indicator driven by small gears, as shown in detail B.



Aileron and trim tab controls. Detail A shows operating mechanism of left hand tab, controlled from cockpit by turning knob. Travel of cables is restricted by stops, and adjustments are made by means of turnbuckles. B is detail of right aileron tab adjustment, set on ground and shows method of attaching and actuating aileron cables by link from stick attachment.

vertical-mast type. Receivers and transmitters are aft of seat.

Gunnery equipment consists of four fixed .50-cal. guns in pairs in wings, in canted position, rotated 60 deg. to prevent protuberances. They are adjusted to converge fire with center line of airplane at 300 yd. Lateral adjustment of ½ deg. is provided on either side, and guns are quickly removable through doors in upper wing surface. Ammunition is fed to top sides of guns through stainless steel chutes. Cases and links are ejected through metal chutes in lower wing skin. All four guns fire simultaneously, control being by switch on control stick. Sighting is through optical gun sight or auxiliary ring-and-bead sight. Electric heaters are attached to each gun, permitting them to function at temperatures as low as −70 deg.

A removable, streamlined bomb rack is provided on each outer wing panel for bombs up to 500 lb., depth charges, chemical, or auxiliary fuel tanks. Fusing of bombs is electrically controlled from cockpit, and bombs can be dropped in a dive, level flight, or 30-deg. climb. Sway braces are integral with racks.

FAN COOLING "UPS" ENGINE PERFORMANCE*

PART I

By **KENNETH CAMPBELL,** *Senior Project Engineer, Wright Aeronautical Corp.*

A pointed and thorough discussion of theory and experimentation leading to noteworthy savings in brake horsepower through employment of fan devices to force cooling air past the engine in high-altitude flight.

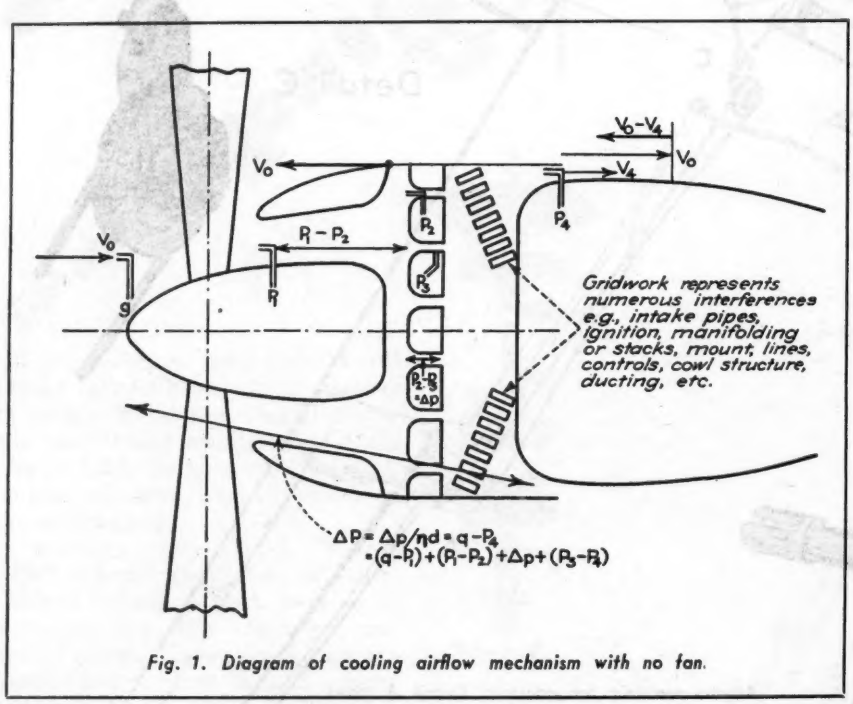


Fig. 1. Diagram of cooling airflow mechanism with no fan.

COOLING FANS comprise only one component of performance improvement through cooling development. Table I shows the place that cooling fans occupy in cooling improvement opportunities. But, unlike the other components of Table I, they offer much greater and more immediate returns than any of the others. Worth-while improvements in rate of climb, top speed at high altitude, ceiling, useful load, or cruising economy, are to be had from fan application.

Objective I (Table I) is strictly an engine-development matter. Much research has been done on methods "a" and "b" in the past ten years, but important gains are forthcoming from current work. Particularly beneficial is the redesign of fins to recognize the rise of air temperature along the path. It has been asked, why not reduce volume, instead of baffle pressure drop. Reducing volume requires disproportionately increased baffle pressure drop or, with fins redesigned to avoid this, it causes severe temperature rise in cooling passages, defeating the objective of cooling the hotter rear portion of cylinder.

Regarding method "c," an increase of 50 deg. F. in allowable head temperature reduces baffle pressure drop required almost one half for given cylinder and baffle design. The designer is aware of this from a drag cost standpoint; the engine (if we may personify it) does not always agree when asked to endure satisfactorily 150 type-test hours. If the pilot wishes to raise temperature limits for combat periods he may—and, we know, he does and comes home.

As for method "d," fuel injection into the cylinders appears to offer the best solution. Uniform mixture strength distribution on carburetor engines is most difficult due to the air-stream's making a 70 deg. to 90 deg. bend approaching the supercharger impeller entrance. The greater the aerodynamic perfection achieved in this passage the greater is the deviation of the fuel streams from uniformity.

Objective II (Table I) has been promoted most from extensive fundamental analysis long since completed and published by the NACA. In spite of this, the number of installations which place a high premium on method "a" are markedly few. These losses are usually tolerated in the interest of space saving or center-of-gravity compromises costing (under marginal cooling regimes with large engines) several hundred thrust horsepower per nacelle, if this can be called a "compromise." As will be seen shortly, the subject happens to be intimately bound up with cooling fans.

Energizing the cooling airstream from within (method "b") gives performance gains due to cooling drag reduction which are startling to the uninitiated, bringing increase in performance in nearly all useful regimes. This can include cruising, according to flight-test data on one of our recent applications.

A straightforward and simple principle

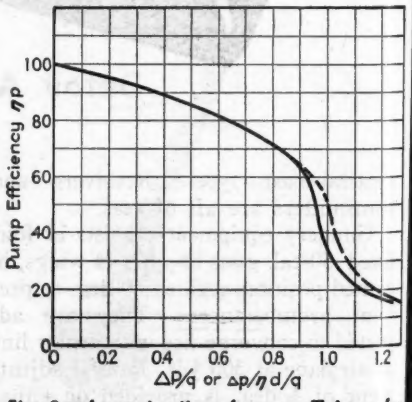


Fig. 2. Approximation of pump efficiency for cooling fan evaluation.

* Paper presented at National Aeronautic Meeting, SAE, Apr. 5, 1944.

TABLE I—Development Opportunity for Reducing Thrust Horsepower Consumed in Air Cooling of Engines

(Exclusive of Internal Coolants)

Objective I

To reduce the baffle pressure differential across engine by—

a. Better heat transfer design of internal cylinder structure, fins, and baffles, particularly in region of highest temperatures or stresses.
b. Reducing restrictions to external air flow across engine in series with fin passages.
c. Developing metallurgical, structural, and combustion chamber design to permit generally higher head temperatures.
d. Improving uniformity of mixture strength and charge distribution among cylinders, reducing somewhat hottest temperatures.

Objective II

Given a required pressure differential across engine, to reduce large additional losses in rest of system used to obtain it by—

a. Reducing pressure drops entering and leaving cowl or duct system and approaching and leaving engine.
b. Adding energy to cooling airstream within system, discharging it rearwardly more nearly at flight velocity, either by a cooling fan (as here outlined) or by exhause stack ejector action.

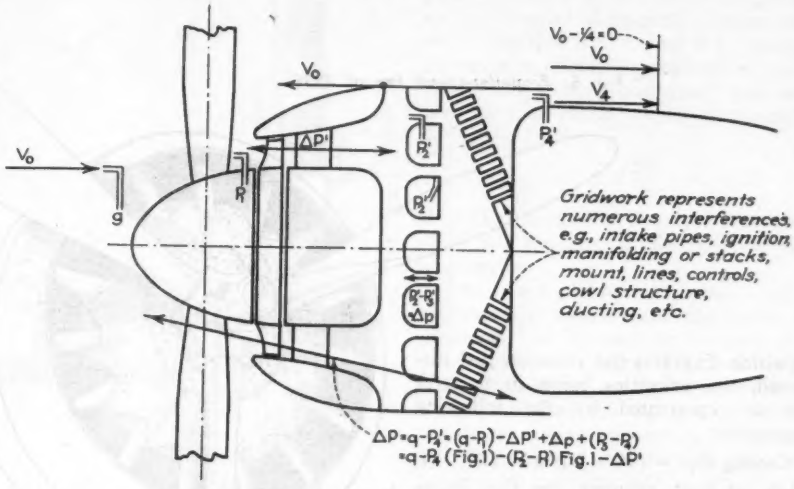

Gridwork represents numerous interferences, e.g., intake pipes, ignition manifolding or stacks, mount, lines, controls, cowl structure, ducting, etc.

Fig. 3. Diagram of cooling airflow mechanism with fan.

of vital importance to airplane performance has been confused for years with all its many influencing variables and mathematical niceties. Rigorous and elegant expositions have perhaps left some responsible designers inappreciative of the real performance dividends to be gained by applying this simple principle to engine installations. This, we believe, has been the cause of many serious deficiencies in performance from the expected, even on recent important designs (meantime, our apologies to those steeped in the subject, to whom the above remarks do not apply).

The analysis which follows is open to criticism from the meticulous on many counts; but its purpose is simplicity—to promote important performance improvement which can still be had for the asking.

The simplest and best physical conception of the cost of cooling air flow is the over-all measure of thp. consumed. The free air at zero absolute velocity is first picked up by the advancing entrance opening and is accelerated to absolute flight speed in front of the engine. Then, after using a little or a lot of the pressure energy thus created to overcome the several required pressure drops built into the cowling passages, including the engine proper, the remainder of the pressure is used to accelerate—a lot or a little, respectively—the air out in a rearward direction.

But since the relative exit velocity from the system ordinarily does not equal the speed of flight (because it is generated by a pressure less than the initial flight dynamic pressure q), the exhausted air still retains a forward component of absolute velocity after it is discharged (forget the heat effect for the present). This exit velocity deficiency, or forward component of absolute velocity, times the mass flow per second is an mV value, or thrust. That is, the airplane has been subjected to a net rearward thrust, or drag, in order to put forward velocity energy into the discharged cooling air which originally was at zero velocity.

This thrust, acting on the plane at flight velocity, results in a certain thp. consumption, all chargeable to cooling. It is always greater—much of the time is several times greater—than the power required merely to force the cooling air through the engine baffle passages. It can, in several ways, be reduced.

Referring to the nomenclature of Fig.

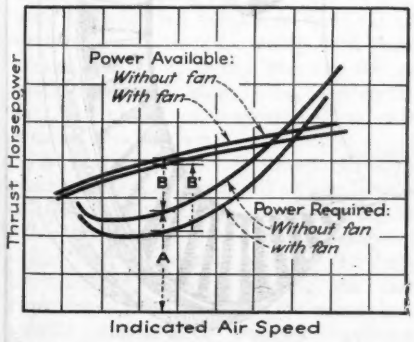


Fig. 4. Contribution of cooling fan to rate of climb.

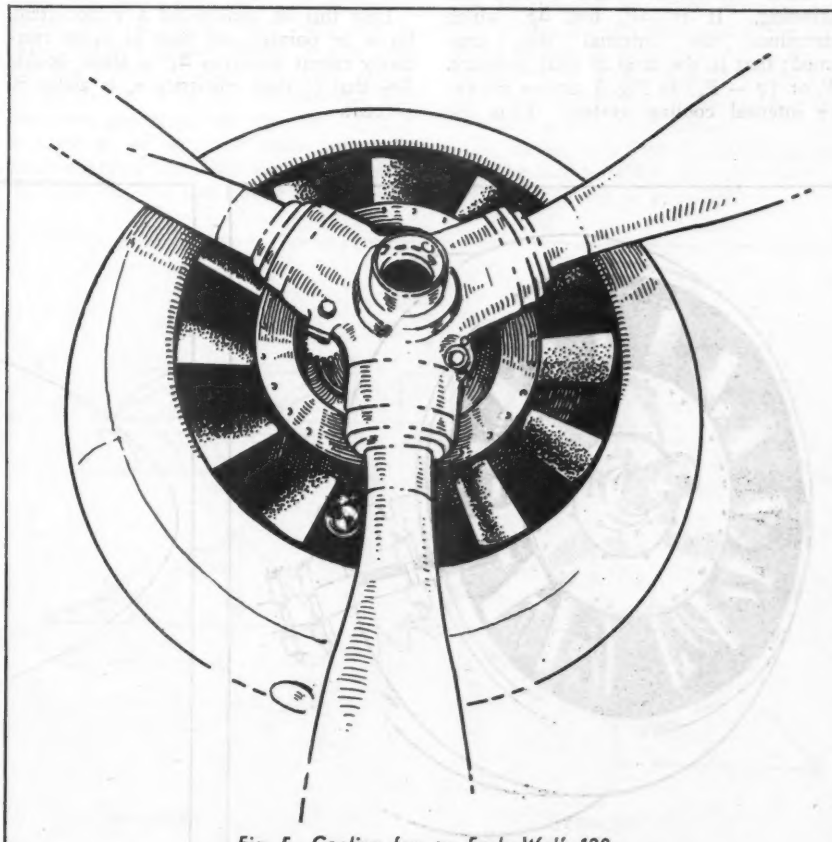
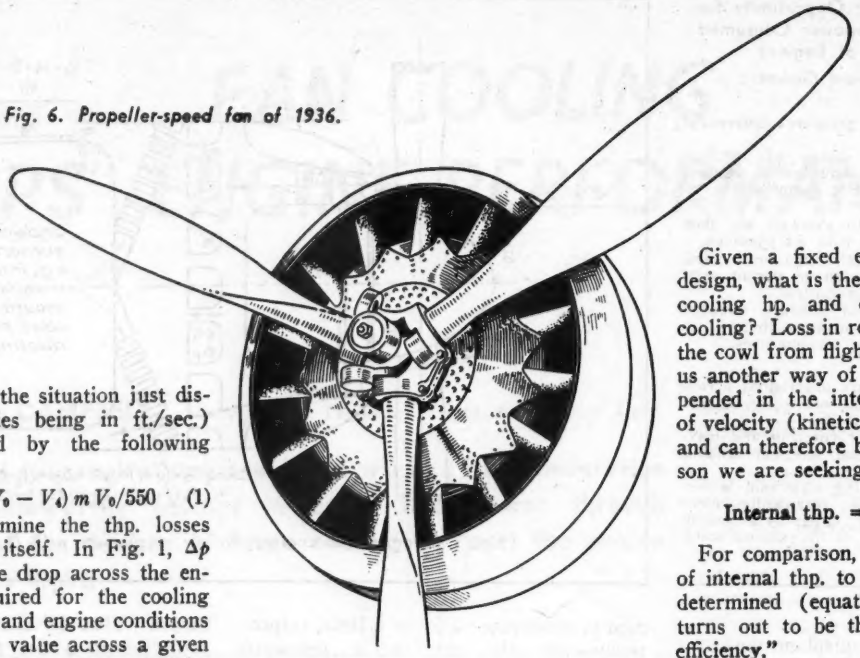


Fig. 5. Cooling fan on Focke-Wulf 190.

Fig. 6. Propeller-speed fan of 1936.



1 (which diagrams the situation just discussed, the velocities being in ft./sec.) this is represented by the following expression:

$$\text{Cooling thp.} = (V_0 - V_4)\, m\, V_0/550 \quad (1)$$

Let us next examine the thp. losses within the cowling itself. In Fig. 1, Δp is the baffle pressure drop across the engine (in psf.) required for the cooling for the atmospheric and engine conditions prevailing. This Δp value across a given engine model in turn meters a definite volume Q in cu.ft.sec., determined in the engine manufacturer's laboratory and corrected for density. The power required to force the air through the engine is then:

$$\text{Engine cooling thp.} = Q\,\Delta p/550$$

Per our Objective I (Table 1) considerations, the engine manufacturer is devoted to reducing the Δp required and thereby the component of cooling thp. for the engine passages alone. But this opportunity for improvement is only the beginning. It is ΔP, not Δp, which determines the internal thp. consumed; that is, the drop in total pressure, ΔP, or $(q - P_4)$ in Fig. 1, across the entire internal cooling system. Thus the engine Δp must be divided by the first of our efficiency factors, "duct efficiency" η_d, to convert baffle drop which the engine manufacturer finds necessary, to the drop which the airplane manufacturer must provide by virtue of his own propeller shank losses, ducting restrictions, and other turbulence losses. The total thrust horsepower devoted to internal cooling then becomes:

$$\text{Internal cooling thp.} = Q\,\Delta p/\eta_d\,.550 = Q\,P/550 \quad (2)$$

Lest this be considered a minor item, let it be pointed out that in some relatively recent airplanes ΔP is about double Δp; that is, duct efficiency η_d is about 50 percent.

Given a fixed engine and installation design, what is the ratio between internal cooling hp. and over-all total cost of cooling? Loss in relative velocity through the cowl from flight speed V_0 to V_4 gives us another way of expressing energy expended in the internal system in terms of velocity (kinetic energy loss or $\frac{1}{2}\, mV^2$) and can therefore be used in the comparison we are seeking:

$$\text{Internal thp.} = \frac{\frac{1}{2}\, m\,(V_0^2 - V_4^2}{550} \quad (3)$$

For comparison, we now take the ratio of internal thp. to total cooling thp. first determined (equation No. 1), and this turns out to be the long-famous "pump efficiency."

$$\eta_p = \frac{\text{Internal cooling thp.}}{\text{Total cooling thp.}} = \left(1 + \frac{V_4}{V_0}\right) \quad (4)$$

The ratio of drop through the cowl passages and engine to dynamic head available $\Delta P/q$ is of enormous importance to performance, and we will need to express pump efficiency in these terms instead of velocity. Since velocity is nearly proportional to the square root of the pressure differential creating it, pump efficiency, as expressed in Equation (4), becomes:

$$\eta_p = \frac{\text{Internal cooling thp.}}{\text{Total cooling thp.}} = \tfrac{1}{2}\left(1 + \frac{\sqrt{q - \Delta P}}{\sqrt{q}}\right)$$

$$= \tfrac{1}{2}\left(1 + \sqrt{1 - \frac{\Delta P}{q}}\right) \quad (5)$$

This ends the chase for something we

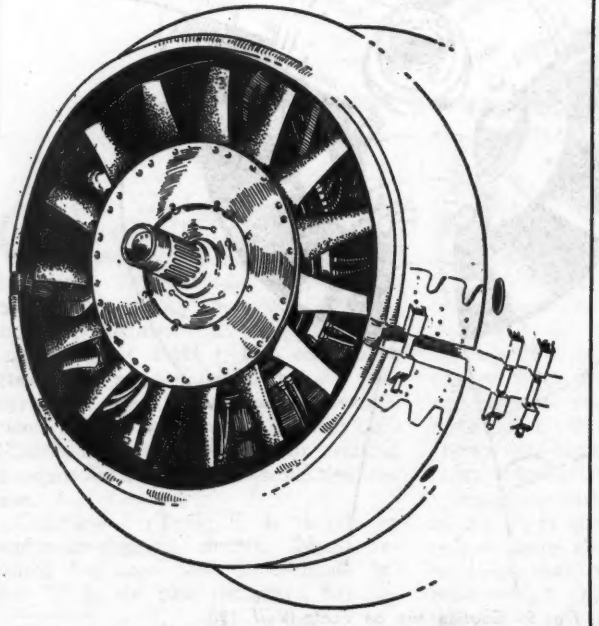


Fig. 7. First geared fan designed in 1939.

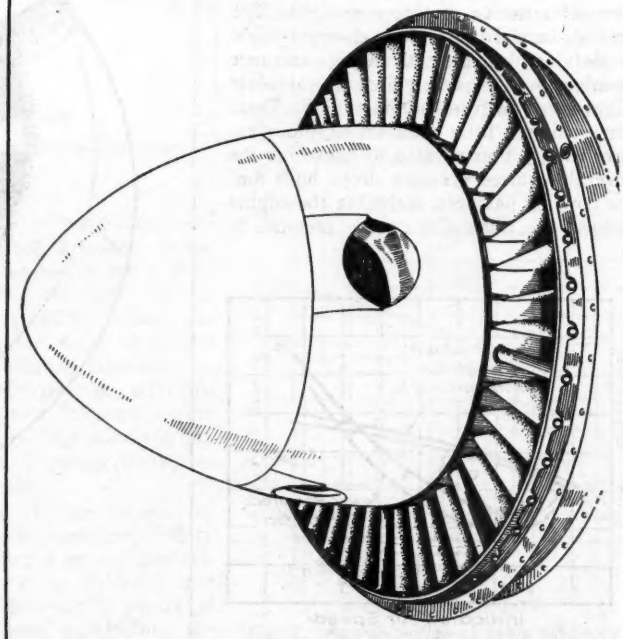


Fig. 8. Complete installation of high-altitude geared fan.

can use to approximate cooling drag. The important objective is still to understand the vast implications of this expression. It explains many a disappointing shortage in performance and offers many a partial fix for built-in trouble.

It is readily seen from either of these expressions for pump efficiency that if P/q could ever equal 1 (that is, if all the dynamic head q available were dissipated in overcoming the cowl ΔP required) cowl efficiency would be only 50 percent. This means that for such a condition the airplane would be deprived of twice the thp. consumed in the cowling and engine passages.

If, now, we assume values of the ratio P/q, we can plot pump efficiency against $\Delta P/q$ or $\Delta p/\eta_d/q$ (Fig. 2). Note the trend of rapidly decreasing efficiency or multiplying penalty in total thp. robbed from airplane as ΔP required by the cowling and engine becomes more and more nearly equal to the available head q.

Above expressions for cowling efficiency become imaginary for values of $\Delta P/q$ greater than 1, which condition represents the induced cooling (cowl flaps) to obtain more than available dynamic head across cooling system. But we all know there is nothing imaginary about the increased drag encountered in the wind tunnel with flaps open. Extending cowl flaps into the passing airstream to obtain some depression beneath them increases the total drag even more disproportionately for the increased differential across cowling. Since our results are now being influenced by parasite drag as well as by further pumping loss energy added to discharged air, all in the interest of cooling, and all nacelle designs differ, no accurate universal curve of pump efficiency above values of 1.0 for $\Delta P/q$ can be computed. But there is experimental evidence that it continues to decline for further increase in $\Delta P/q$, then probably flattening off, as indicated by dashed line of Fig. 2, to values at best as low as 15 or 20 percent at 1.3 $\Delta P/q$.

Furthermore, contrary to the simplified algebra above, the cowl flaps actually must be opened before the $\Delta P/q$ required is increased to unity. The reason for the drop through the system is that a predetermined cooling air flow is necessary. Without additional drop across the cowl induced by the flaps, no flow would exist when $\Delta P = q$, which implies zero velocity out the exit, contrary to the principal objective of achieving a flow. The flaps must begin to be used when $q - \Delta P$ leaves just sufficient total pressure P_4 before the exit to cause the specified volume to flow out of the chosen size of exit opening with flaps streamlined. This means that the ΔP at which flaps must begin to be used varies with the choice of normal-position exit opening area allowed.

Lower line of Fig. 2 shows effect of making an approximate allowance in calculations for additional pressure drop, as $\Delta P/q$ approaches unity. Some designers defeat their purpose of reducing the drag by designing the exit area so low that flaps must be opened in the more frequently encountered regimes, applying penalty of induced cooling which could have been avoided.

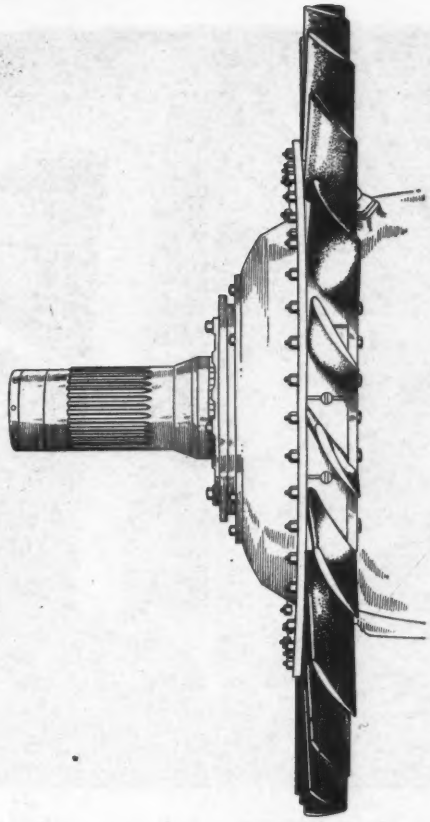


Fig. 9. High-altitude geared fan rotor.

Examine again the disastrous effect on cooling thp. consumption caused by excessive over-all drop through cowl and engine passages. Assume, as an extreme case, that the total cowl drop, ΔP (or $\Delta p/\eta_d$) is twice what it might have been, due to unsatisfactory engine design, to cowl and ducting design, to propeller shank effects, or all three. If by this increase we find ourselves operating with the flaps open at a value of $\Delta P/q$ of 1.2 when we might have operated with the flaps closed at a $\Delta P/q$ of 0.6, the curve of Fig. 2 tells us we are saddled, roughly speaking, with a pump efficiency of only about 20 percent, instead of about 80 percent. Having previously seen that the internal thp. consumption is also doubled (proportional to the $Q\Delta P$, and Q is a prescribed constant), then the total cooling thp. with the higher ΔP is —

$$2 \times \frac{80}{20}$$

or eight times what it might have been with half the drop P through the cowl and engine.

This is not just another minor variable of interest to those specializing on cooling problems; for hp. and performance costs can be extremely large. The more favorable values above are moderate enough—between 50 and 100 thp. per nacelle for the larger engines, depending on altitude. That means the unfavorable case just assumed is consting 400 to 800 thp. per nacelle. Gains from recent external refinements look small indeed by comparison with possibilities missed here. If these horsepowers are extreme for actual practice, it is only because the manufacturer has decided not to permit flaps to be opened enough to pay this penalty. With far less pressure-drop from flaps, however, he runs into cooling difficulties.

So much for built-in cooling drag and its effect. A fan can eliminate the disproportionate fall-off in pump efficiency accompanying high values of $\Delta P/q$, in marginal cooling regimes cutting cooling drag perhaps to one third. Fig. 3 represents the same flight conditions as Fig. 1, and the same installation, except for addition of a fan. Let $P_1 - P_2$ be that portion of ducting loss now included as a part of the fan structure and P' be boost added by fan at cylinders. ΔP is the remainder of original total P which must still be provided by cowl system after subtracting fan contribution.

To simplify this first illustration, assume that the fan provided the entire ΔP re-

(*Turn to page* 258)

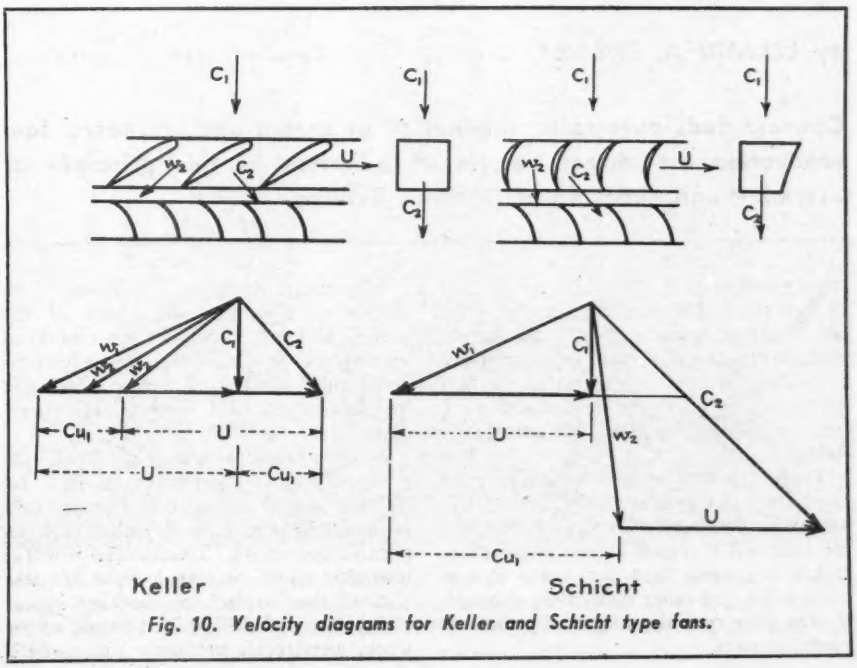
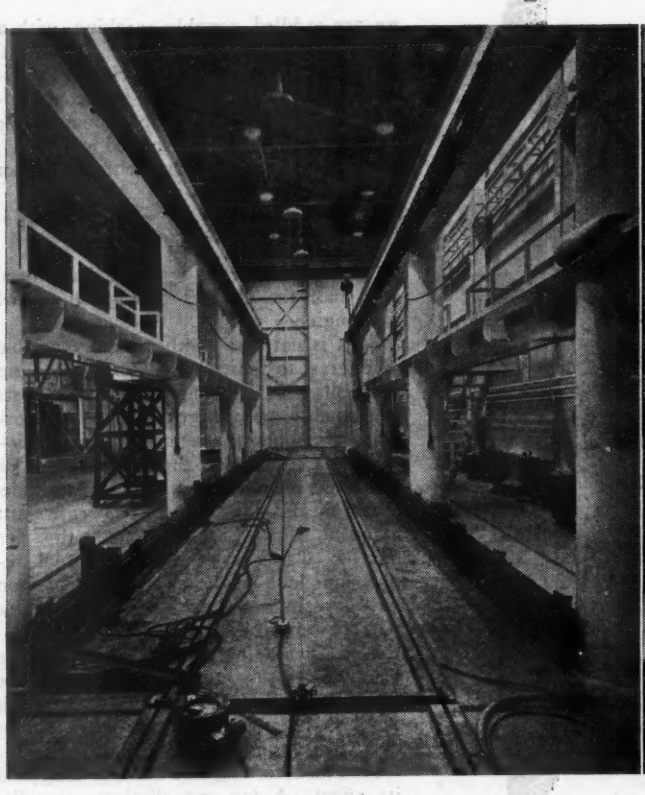
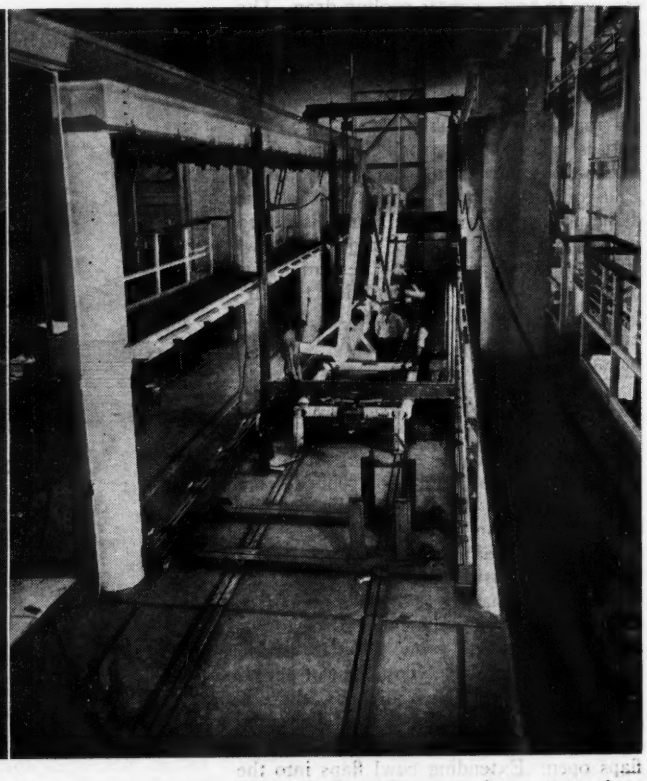


Fig. 10. Velocity diagrams for Keller and Schicht type fans.



Inside view of Convair's tooling dock, showing massive framework. Note catwalk halfway to top. Fluorescent lights are to be installed under this catwalk. Dark beams (top and bottom) are horizontal straightedges for aligning work.



In this view, vertical and cross straightedges have been set in place. Overhead gantry crane handles parts which are too heavy for movement by other methods. White object in center is jig being lined up either for checking or addition of parts.

TOOLING DOCK TECHNIQUE SAVES TIME, SPEEDS ACCURACY

By LELAND A. BRYANT, *Consulting Engineer, Consolidated Vultee Aircraft Corp.*

Convair finds automatic elimination of errors and increased tool production are direct results of adoption of this principle of assembly and checking of jigs and fixtures.

NEW DEVELOPMENTS in the use of jigs and fixtures in place of older layout systems have so revolutionized this part of aircraft manufacturing as to make it quite probable that production costs will shortly be reduced to a level paralleling those in the automobile industry.

There are two reasons which may be cited—one old and one new. The new reason is the master tooling dock; the old reason is a system known as paneling, which has been used for years in the automotive and other industries, although it was only recently adopted by aircraft manufacturers.

Essentially, the idea of paneling is as simple as the basic idea back of the tooling dock. It consists of breaking down an airplane or automobile, into numerous small subassemblies or panels which can be fabricated with considerably more speed.

Before paneling was introduced, the practice was to construct huge jigs and fixtures used to assemble each major part of an airplane in a single series of complicated operations. The number of workmen that could be placed on a job was limited, due to lack of working space; and, because of the involved nature of the work, an aircraft mechanic had to be a combined craftsman and contortionist. The process was slow and tedious, because only a limited number of operations could be accomplished simultaneously.

Breaking down airplane construction by paneling makes it possible to utilize comparatively simple jigs and fixtures spread over a large work area. Many workmen can be used on each job, because there is no lack of space. Even unskilled help can be employed, because the individual operations are simple and easy.

One difficulty presented by paneling in the aircraft industry was the problem of obtaining appropriate tools. With inadequate dimensional control that prevailed in aircraft building before the war, paneling was impractical because it necessitated precision assemblies. To be successful, all components must be interchangeable. There must be precise means of coordinating the assemblies well within stipulated manufacturing tolerances.

Considering the complications involved in setting up accurate jigs and fixtures, aircraft tool designers were inclined to

Ship stations are located by strip template, shown on top corner of straightedge. Next, station fittings are set in place, then bolted firmly down. Strip template is then used to locate other parts requiring same dimensions, thus assuring same spacing throughout stations.

conclude that it would be easier to build a few large tools rather than many small ones. What the aircraft industry really needed was a universal mastering device, and it was with this in mind that the master tooling dock was adopted by Consolidated Vultee Aircraft Corp. Besides speeding up the entire building process, we have been able to attain dimensional tolerances seldom before considered practicable.

The dock is a three-dimensional positioning apparatus used for setting up assembly tooling fixtures and master jigs and for production checking. Besides facilitating precision duplication of lofting, it provides automatic coordination in the making of both fixtures and prototype assemblies. It eliminates the use of transits, surface plates, and height gages. It provides precision checking and speeds up the job of duplicating previously-fabricated fixtures.

Thanks to the tooling dock, most errors have been eliminated in building fixtures. Dimensional control over templates is fixed by the sources that control parts fabrication—that is, in the loft and template departments.

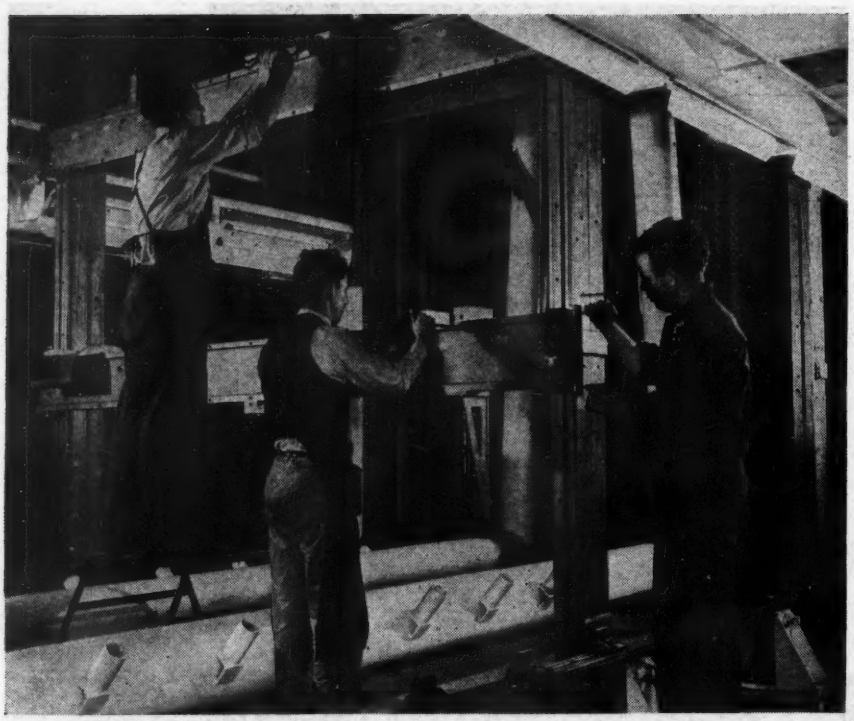
The tooling dock is a reproduction of the loft grid lines or planes. Its dimensional positioning in any of the three geometric planes is accomplished by means of coordinated strip and index templates, generally referred to as dock templates. Since a permanent record of each fixture exists in the dock templates, and since the dock is unchanging, it is only necessary to re-set the templates in the dock to check, realign, or duplicate the original fixture. This practice is limited only by the size and availability of the jig.

In some instances, the size of a fixture might prohibit its being moved to the dock, or it may be shipped to a location where a transportation problem exists. Thus, it is advisable to construct a standard master gage.

When a master contour model is required, the dock is used to align the templates. The master contour model is not completed when the station contour templates are secured to the backbond of the steel skeleton; it must still be filled and faired to produce a smooth, curved body.

Upon the surface of this model the lines layout is developed, with indications of trim lines, hole patterns, stringers, and lines of other secondary parts. From this contour model are lifted the form and layouts for stretching and forming dies, and drill fixtures required form the parts. The normalized steel skeleton, in conjunction with the inert plastic filler, insures preservation of line and form in the model. Through use of the tooling dock in positioning templates identical with the assem-

After location of stations, vertical straightedges are set in place by overhead crane. Weight is taken by jack under lower end, while positional accuracy is assured by ground and tapered dowel pins set through straightedge into fitting, the location of which was shown in top illustration.



Transverse straightedges are next set in place and their accuracy checked by some methods used in locating vertical units. Note that two straightedges—upper and lower—are used, with identical cross dimension markings, so that vertical accuracy can easily be obtained.

bly fixtures, automatic coordination with the jigs is established.

For lack of means by which the loft and template departments might control the making of fixtures, it has been the practice to use dimensions and measuring apparatus in the jig and fixture department. As a consequence, the tool makers constructed assembly fixtures in a series of individual enterprises. Obviously, the difficulty of effecting coordination under such circumstances has been a great source of trouble in every tooling program throughout the whole war effort.

Through the use of the tooling dock, assembly tooling can be started almost at the inception of the design of an airplane. The first accessory, the strip template, can be completed as soon as the basic station dimensions are determined; and the second, the index plate, may be completed as soon as hole locations are shown on the master layout, well ahead of other detailing.

Prior to the advent of the tooling dock, accuracy of dimensions in setting up assembly jigs was difficult to attain. Since each dimension must be linear—and since fixation of a point in three dimensions involves not only an accumulation of tolerances but also requires that each of the three measurement be in precise relationship—the difficulty is evident.

In lofting it has been general practice to work to tolerances of .010 in., and less, but in lofting all work is done in the second dimension, i.e., upon flat surfaces.

The tooling dock affords means of projecting the products of two dimensional layout into the third dimension without reduction of these tolerance limits. The straight edges of the tooling dock, set up in three planes, afford positive means of

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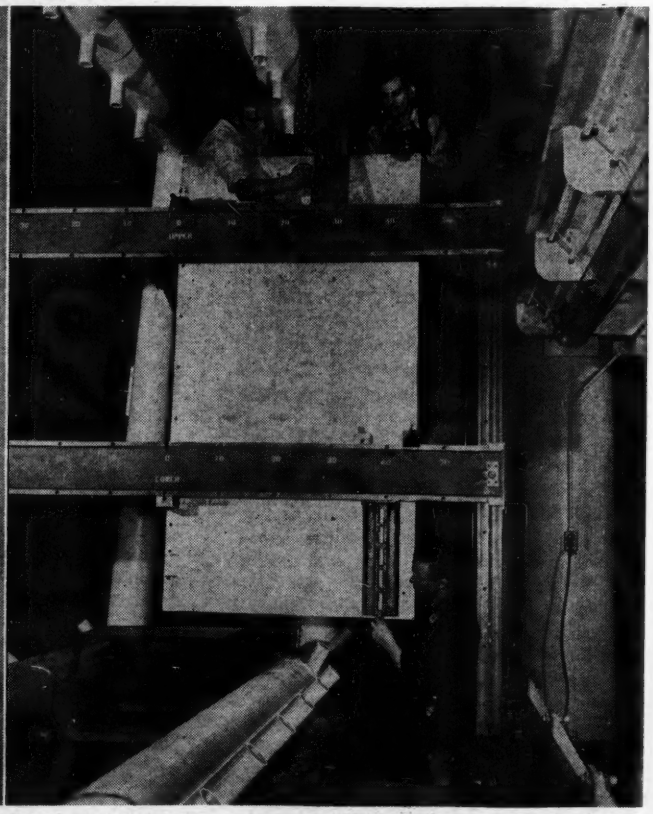
As vertical adjustments will be required in mounting templates, slotted angle blocks are attached to transverse straightedges. Drilled and numbered holes line up angle plates accurately.



Last stage is attachment of index template, with one edge on center line of jig. Angle blocks enable adjustments to be made without changing position of straightedges.

SO YOU'RE GOING TO PRESSURIZE?

By **CHARLES W. MORRIS,** *AiResearch Mfg. Co.*

What the Sales Department wants to sell and the Engineering Department wants to deliver are two different things. Here are some of the basic kinks and how they can be ironed out.

IT IS OBVIOUS to the technically minded that the problem of supplying air to an airplane cabin and controlling the pressure in the airplane cabin is not difficult. All that is necessary is to provide a source of air of adequate pressure, and to provide a control valve in the cabin which will maintain the conditions desired in flight; i.e., a "low altitude" cabin, although the airplane may be flying at higher altitudes.

We may assume, for convenience, the example of a transport-type airplane, which may be likened to the *Stratoliners* operated commercially by TWA and Pan American Airways. A certain amount of air must be provided, with control by some cabin inflow measuring means. This will assure an approximate constant quantity of airflow to the cabin. The outflow may be controlled so as to maintain an essentially constant pressure in the cabin.

In current advertising we note the trend toward promotion of the future probability of pressurizing airplane cabins for the comfort of the passengers and crew. In these advertisements we see a beautiful, shapely airliner with glistening surfaces, and the reading matter tells us it is operating in the stratosphere or substratosphere—depending upon the optimism of the Sales Department.

Such a future possibility is shown in Fig. 1. An airplane of this sort may be the one which is purchased by an airline operator for commercial transport work, to afford the maximum economy of operation and maximum sales appeal to potential customers.

In selling this airplane, the Sales Department of the particular airplane manufacturer will undoubtedly extoll the pressure-type cabin in which the passengers are riding "in luxuriant ease" and that, with the new speeds, the passengers "will hardly have doffed their hats in settling themselves for their trip before putting their hats back on again, preparatory to disembarking at their destination."

But in order to meet the Sales Department's promises for an *airtight* cabin, the airplane would have to look somewhat as shown in Fig. 2. The practicability of such construction *may* be subject to question. The engineers will probably deliver an airplane more like that shown in Fig. 3.

Every imperfectly driven rivet, each skin-seam wrinkle, each door and window, has some bit of leakage. There are leaks inside the airplane where the controls pass through packing glands. Each point that a bolt, screw, or rivet passes through the skin is a potential source of leakage.

It becomes obvious that when we consider the cabin pressure control problem, the leakage and the expected variation in leakage with altitude must be given close consideration.

Current practice to provide more than a minimum of 10 cu. ft. of air per person per min., with a maximum of 30 cu. ft. of air per person per min. being used for an upper limit. The derivation of these requirements is not known by the author,

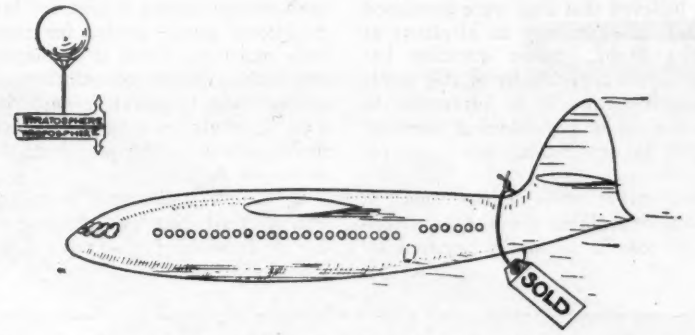


Fig. 1. This is what the Sales Department would like in the way of pressurized-cabin planes for stratosphere operations.

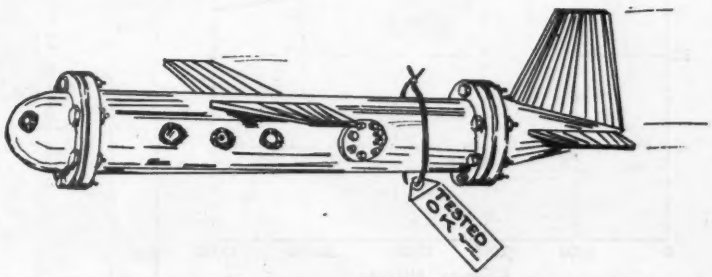


Fig. 2. To meet sales' desires for an airtight cabin, engineering would have to deliver something like this.

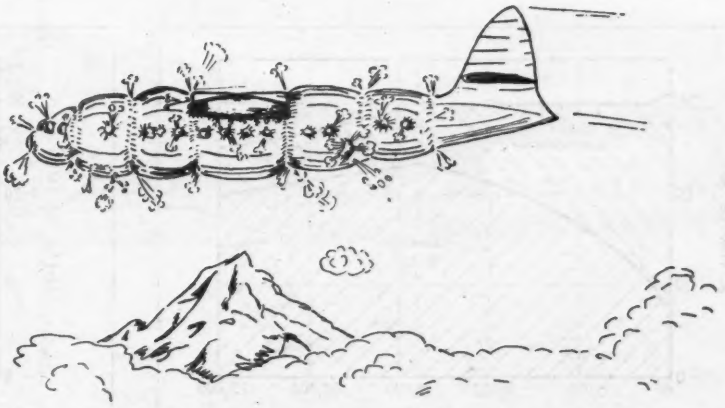


Fig. 3. What might be delivered, by way of compromise, could easily look like this, with every rivet hole, door, and window "busting at the seams".

Based on a paper presented before the American Society of Mechanical Engineers' annual meeting.

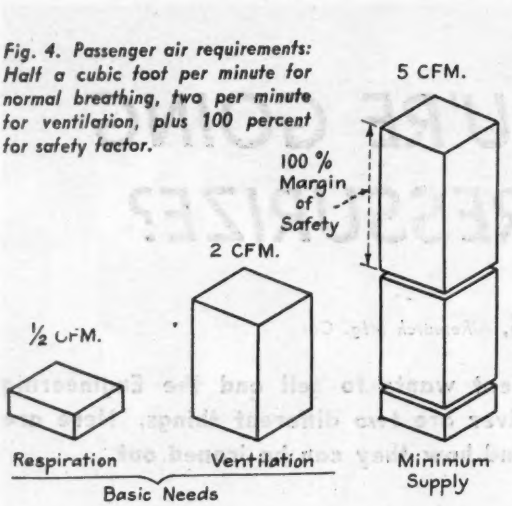


Fig. 4. Passenger air requirements: Half a cubic foot per minute for normal breathing, two per minute for ventilation, plus 100 percent for safety factor.

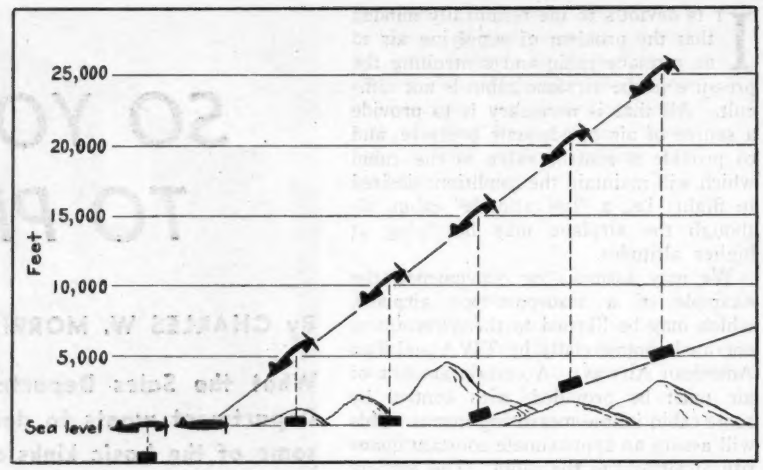


Fig. 5. Relationship of actual airplane altitudes to cabin altitudes.

but it is believed that they were developed as a result of experience in airplanes at least 10-yr. old. Some question has arisen as to the applicability of this ventilation requirement. It is interesting to analyze the actual physiological needs of passengers in determining basic air requirements.

For respiration, while riding relaxed in an airplane or walking passively, approximately 0.5 cu. ft. of air is required by each person during 1 min. for breathing. Additional air is needed for removal of body moisture, which is accomplished by ventilation though the clothing. Under normal room temperatures, approximately 2 cu. ft. of air per min. are required at 60 to 70 percent humidity to meet this need, as shown in Fig. 4.

By simple addition, it is apparent that the total air need per passenger is only 2.5 cu. ft. of air per minute. Let us now double this total air requirement, so as to provide a 100 percent margin of safety, which will indicate a need for approximately 5 cu. ft. of air per minute per passenger. This may be used as a minimum requirement, and would be applicable during conditions of normal room or cabin temperature of approximately 70 deg. F.

With warmer air in the cabin, the

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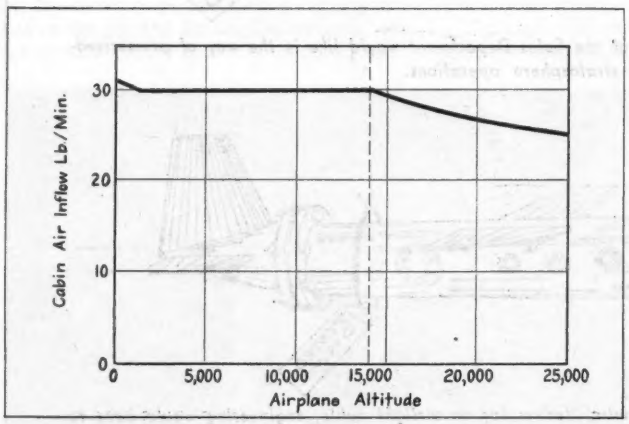


Fig. 6. Cabin air inflow curve, showing constant rate to 14,000 ft., above which it decreases with air density.

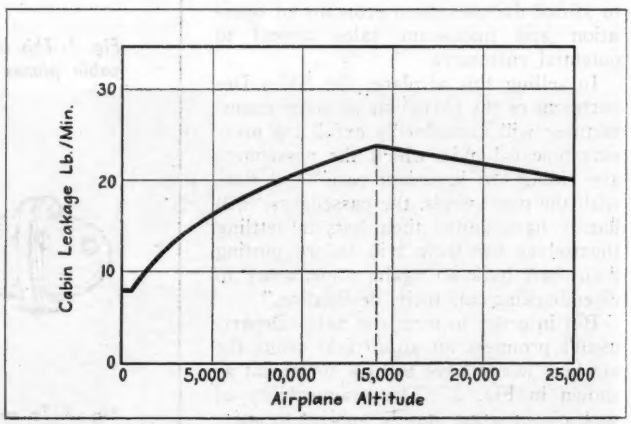


Fig. 7. Slight pressure differential (needed for ventilation) can cause a surprising amount of leakage.

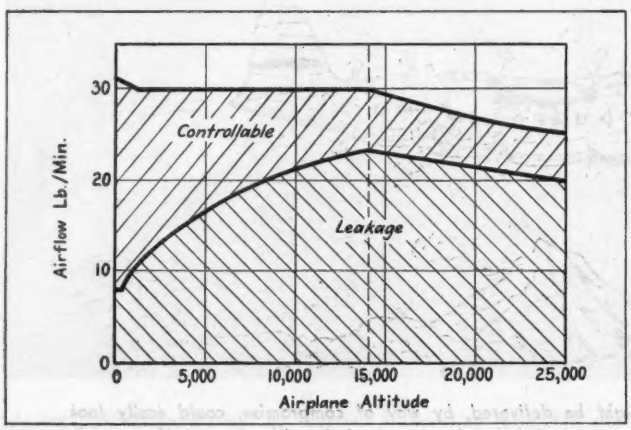


Fig. 8. Combination of Fig. 6 and 7, to show air outflow variation which must be controlled by cabin pressure regulator.

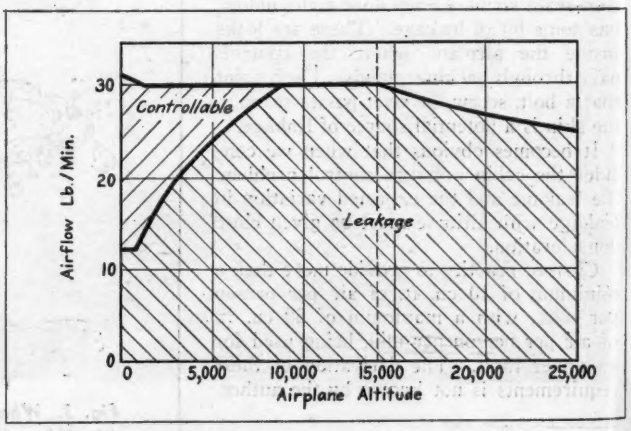


Fig. 9. Service wear increases air leakage; this graph shows how cabin supply and leakage might appear during a plane's life.

The B.F. Goodrich Airline of the month

ALL AMERICAN AVIATION, INC.

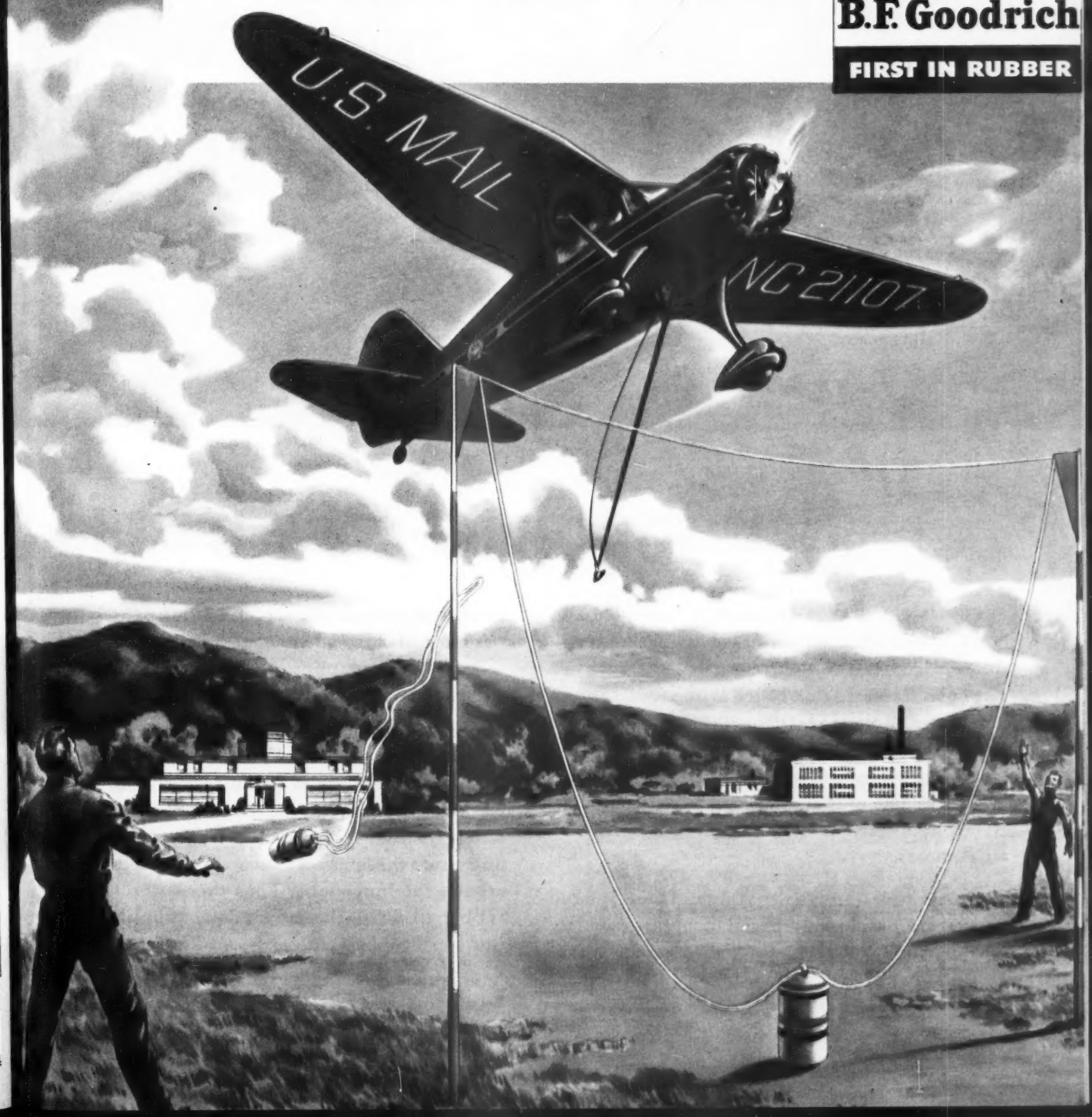
FIVE ROUTES radiating from Pittsburgh, Pa., serve 107 cities and towns in six states with a new form of fast communication—the Air Pick-Up. All American Airlines, Inc., operate a fleet of light, 2-man planes over these routes. They swoop down at pick-up stations—drop a bag of mail and express, and pick up another—all on the fly. By acting as a feeder to main trunk lines, and serving areas without regular airport facilities, All American is bringing closer the day when air service will be available to everyone.

B. F. Goodrich, maker of Airplane Silvertowns, Expander Tubes for brakes, De-Icers, and more than 80 other aviation products, salutes All American for their excellent service record. They've earned the nomination as this month's "Airline of the Month."

In war or peace

B.F. Goodrich

FIRST IN RUBBER



New hydraulic hose means

WHEN A WARPLANE comes back to base with its hydraulic lines shot up, they must be replaced before that plane can get back in the fight. Replacing damaged hose sections used to be a complicated, time-consuming process. Attaching stock hose to couplings required a giant press . . . and not many advanced bases had them. The only alternative was to keep thousands of different hydraulic assemblies on hand at all times.

To improve this difficult supply situation, manufacturers developed special couplings which could be attached quickly and easily to the stock hose then available. But they weren't successful, because the rubber in the hose would stretch and flow when squeezed between the parts of the coupling—then pressure would pull the coupling loose.

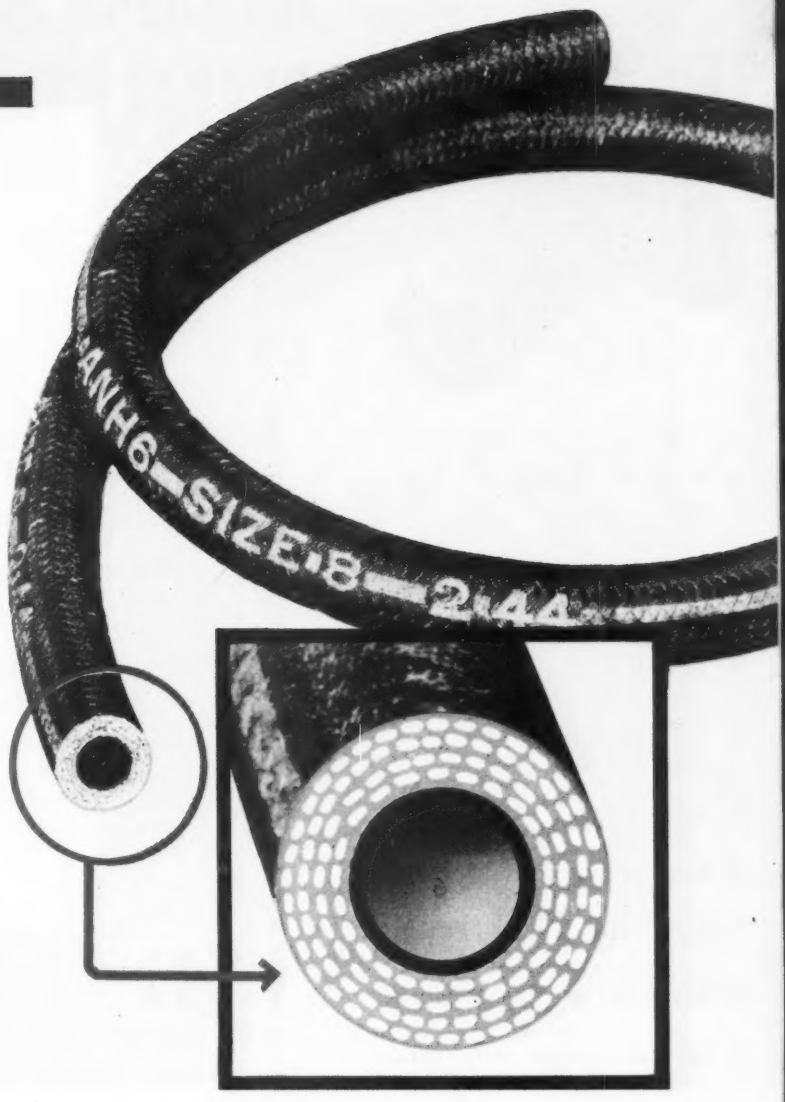
Awards to 9 plants

B. F. Goodrich engineers were asked to develop a hose which would make the use of these couplings practical. The result was a hose with no layers of rubber outside or between the cord plies. Instead, protecting rubber was forced down into the fibres of the cord as it was braided around the inner tube. Thus there was no free rubber to flow—the jaws of the couplings bit into hard rubberized cords only, and held!

This new hose is 30 to 50% lighter and from 20 to 50% stronger than the old type. It is the

STRONGER, LIGHTER HOSE OPERATES AT LOW TEMPERATURE

Here's the new B. F. Goodrich Hose (Spec. ANH6a) that simplifies front-line repairing of the medium pressure hydraulic lines in our warplanes. Since it has no free rubber to stretch or flow, new couplings can be attached and not pull loose under pressure. Specially compounded for use in working conditions as low as —65° F., this hose is now Army-Navy standard for medium-pressure control lines.



faster front-line repair

only hydraulic hose that is size-controlled within such close dimensions that reattachable couplings can be used.

Now Army-Navy standard for aircraft medium pressure control lines, this B. F. Goodrich hose is greatly simplifying front-line repair. For instead of having to stock thousands of different complete assemblies, a few sets of couplings and a few reels of hose are all a base needs to keep its planes in the air. Assemblies are made up on the spot.

The use of this hose has benefited the war effort in another important way. Demand for the type of hose formerly used for both medium and high pressure lines far exceeded production capacity. The adoption of this new B. F. Goodrich Hose for all medium-pressure installations has greatly relieved a critical supply situation. The B. F. Goodrich Co., Aeronautical Division, Akron, Ohio.

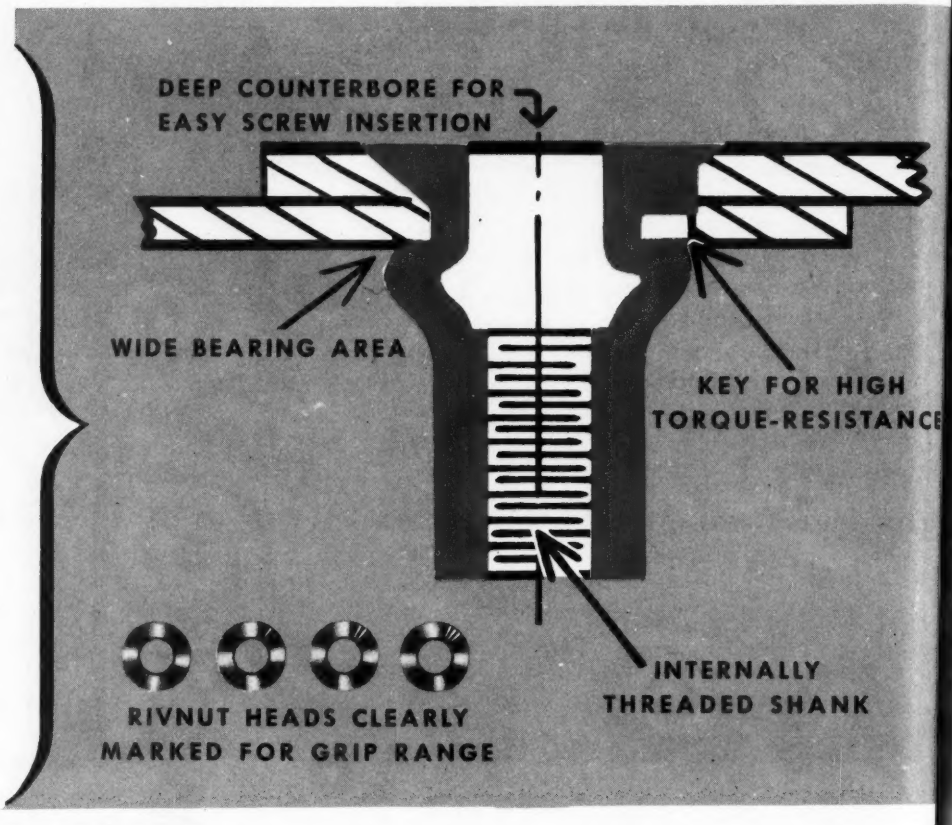
In war or peace

B.F.Goodrich

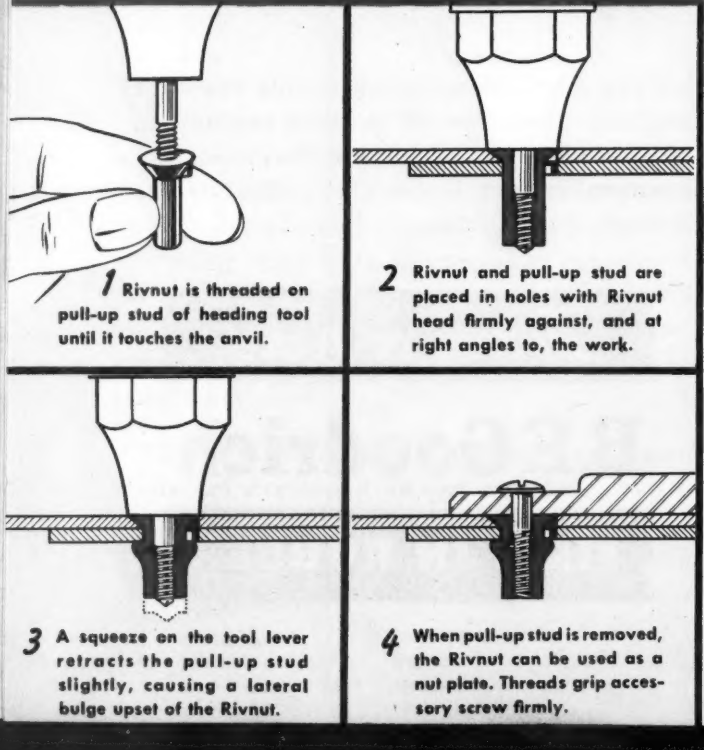
FIRST IN RUBBER

All these advantages make the RIVNUT an ideal blind fastener

- Installed and headed from one side
- Serves as rivet, as nut plate for attachment, or as both at once
- Simple one-piece construction
- Corrosion-resistant aluminum alloy
- Light weight—low cost
- Requires very small hole
- Forms compression fit
- Ready for use "as received"
- Can be used in metal, plastics or plywood


DEEP COUNTERBORE FOR EASY SCREW INSERTION
WIDE BEARING AREA
KEY FOR HIGH TORQUE-RESISTANCE
INTERNALLY THREADED SHANK
RIVNUT HEADS CLEARLY MARKED FOR GRIP RANGE

SIMPLE INSTALLATION IS BIG RIVNUT ADVANTAGE



1 Rivnut is threaded on pull-up stud of heading tool until it touches the anvil.

2 Rivnut and pull-up stud are placed in holes with Rivnut head firmly against, and at right angles to, the work.

3 A squeeze on the tool lever retracts the pull-up stud slightly, causing a lateral bulge upset of the Rivnut.

4 When pull-up stud is removed, the Rivnut can be used as a nut plate. Threads grip accessory screw firmly.

New Folder, "Rivnut Data," Free

If you're not already using B. F. Goodrich Rivnuts, get complete facts now about these versatile fasteners that cut costs and speed production. For your copy of a newly edited data folder, write today to the B. F. Goodrich Company, Aeronautical Division, Dept. 0770, Akron, Ohio.

B.F.Goodrich

RIVNUT

IT'S A RIVET...IT'S A NUT PLATE

In many small assemblies, hole piercing and riveting is done in one or two operations along this conveyor belt line at Glenn L. Martin, Baltimore. Set-up, combined with careful planning extending back into design department, has meant great time-and-tool savings.

HOLE PIERCING PROVES FASTER—AND CHEAPER

PART I

By HERBERT CHASE

Obviating use of drills, Martin system combines with conveyor belt line to simplify and boost production of small assemblies.

WHY DRILL RIVET HOLES—when they can be pierced with a punch and die many times faster? Though the answer may appear obvious, its implications have brought about far-reaching production method changes at the Glenn L. Martin Baltimore plants. Since the remarkable economies realized offer similar "fair shooting" at other plants, the Martin procedure is reviewed here.

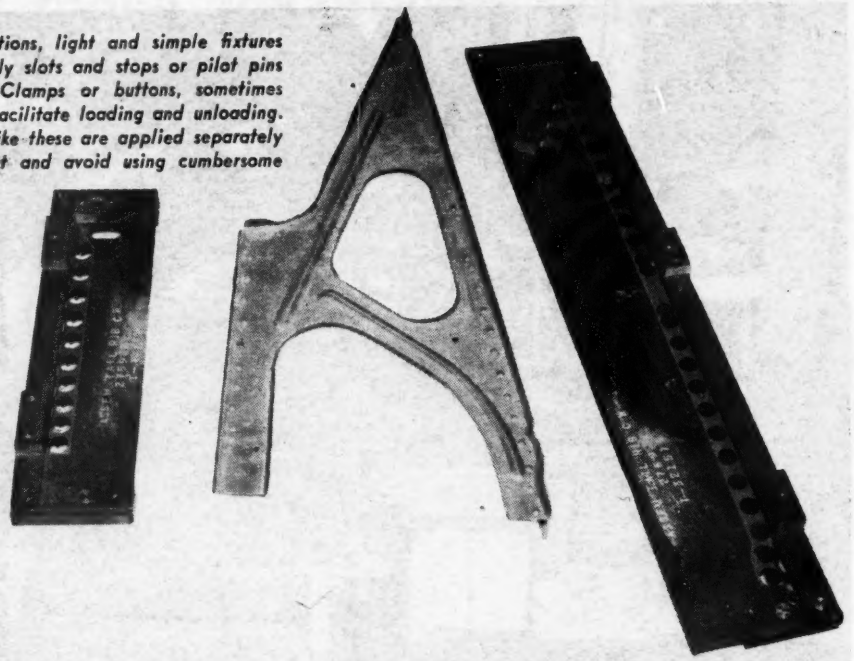
First, however, it should be pointed out that Army and Navy specifications do not preclude driving rivets in holes that are merely pierced with a punch and die and not subsequently reamed or drilled out. Although the Navy, at least, once had a specification to this effect (apparaently based on a belief that cracks occur around pierced holes), it no longer applies. The current Navy specification SD-24-E reads in part:

"Holes for structural rivets, bolts, and pins may be punched or drilled . . . All holes shall be clean-cut and shall show no evidence of excessive deformation at the periphery."

Today, millions of rivet holes, up to 3/16-in. dia., are being punched ("pierced" is the usual term in the stamping industry) daily in aircraft factories, especially on the West Coast, though Martin, in the east, is believed to be making most extensive use of piercing. While it may not be feasible to displace drilling by piercing in making major or large final assemblies, especially of the fuselage, some informed opinion implies that more than 75 percent of all rivet holes can be pierced if the design of parts and production system are devised with this end in view.

Moreover, there is excellent evidence to support the contention that pierced holes, when properly made, have smoother walls, are more precisely sized, and yield superior joints than those commonly produced with drills. Such holes, when pierced with punch and die kept in proper conditions, require no burring, which alone often yields a marked saving in time.

At the Martin plant it is realized that,



For Erco and many other operations, light and simple fixtures (such as these) suffice. Often only slots and stops or pilot pins are needed to position work. Clamps or buttons, sometimes needed, are fast to operate and facilitate loading and unloading. In some cases two small fixtures like these are applied separately to same assembly to save weight and avoid using cumbersome single fixture.

though hole piercing alone affects substantial economies, these savings are greatly increased when the operation combines automatic insertion and driving of the rivet and also, when required, dimpling of the hole. For this reason, preference is given to the Erco machine, since it pierces, dimples when necessary, inserts, and drives the rivet in a rapid sequence of semi-automatic operations. During this sequence, no shifting of the work is necessary. Where this type of machine is not applicable, one machine is used to pierce (and dimple, if required), and a second to insert and drive the rivet.

The third alternative, in order, is to pierce and dimple the hole or holes in one machine, insert rivets by hand and squeeze, preferably in a machine that will squeeze more than one rivet at a time. A fourth choice (often necessary when parts have to be fabricated separately and assembled later (perhaps on the airplane) is to pierce the holes in one part slightly under size and drill through them and the mating during assembly. In this case the piercing, which may be done with multiple punches, serves to spot the holes and shorten drilling time, but rivet insertion is by hand and the rivet is set by a squeezer or riveting gun.

As a last resort, and commonly where none of the foregoing operations are feasible, the entire hole is drilled and dimpled if necessary. Even then, of course (if the assembly is adaptable to machine riveting), rivets are preferably inserted and driven by an automatic riveter, though hand insertions and multiple or individual squeezing or hammer driving may be required.

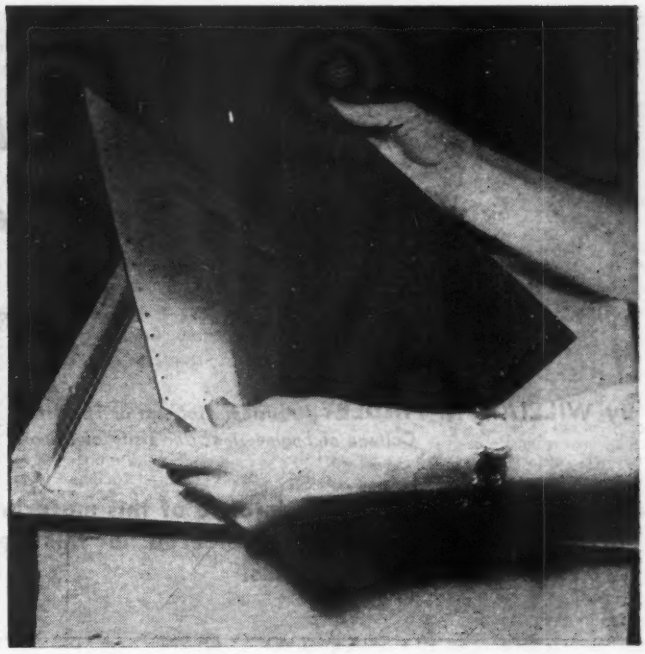
When drilling can be avoided, no drill jig is required. This often saves heavy tooling expense as well as the time of applying and removing the jig or clamping and then removing the work. On the other hand, although jigs and fixtures are often needed for piercing holes and subsequent riveting, these tools are low in cost. They are commonly made from Masonite or similar material, as will be shown later. In much piercing, however, no jig is needed, because holes can be located with ample precision either by eye or by spots of paint or dye sprayed on the work through a template. When piercing in a machine, these spots are brought in line with the punch, usually by directing a beam of light at the spot where the end of the punch is to make the hole.

For maximum economy, especially in building small assemblies, it is often necessary to employ at least a simple fixture and to arrange the series of operations to follow in logical sequence and reach the necessary machines with a minimum of handling and delay. At Martin, much study has been give to simple fixtures that are light, easy to handle, and rapid to load and unload. The same is true of the set-ups required for performing at a maximum rate the succession of operations necessary to effect the assembly.

To realize these economies in small-to-medium-size assemblies normally handled on a bench (where one or more workers commonly perform several hand operations) Martin operates several assembly lines, each with a conveyor belt running through the center. None of the lines is designed for effecting a single assembly or even a few different assemblies; each handles a great many different assemblies on which similar or identical operations are performed. Though there are some

Numerous Martin parts have been designed for speedier assembly through piercing rivet holes. This Erco machine punches holes, dimpling them when necessary, and inserts and drives rivets, usually in cycle of 1-3 sec. Such operations call for same size-and-shape rivets unless conditions permit changing set-up or use of more than one machine.

Where several holes of same size have previously been pierced or drilled and take same type and length of rivets, automatic riveters, such as this Chicago machine, insert and drive rivets. Work is located by pilot pin entering hole from below.



Assemblies in which holes are to be pierced at points where jig location is unnecessary are sprayed or spotted, paint or dye going through holes in template, as shown. If burring is necessary it is done at next station on conveyor belt line.

benches, the usual bench work is avoided along the conveyors. The belt really serves many stations, some of which have no bench space. The operator merely takes the assembly from the conveyor, performs the operations assigned, and replaces the assembly on the belt for transfer to the next station.

In general, only one set of duplicate assemblies is on the line at a time, and most assemblies are handled in batches of 50 or 100. A new batch is usually started before the preceding one is finished, to keep the line operating continuously. Each machine is equipped with the proper tools, which seldom need changing while a given batch of duplicate assemblies is in process.

When machines at a particular station are not needed for a given assembly, the conveyor merely carries the assembly past this station. In every case, however, the aim is have the individual operatons done under the most favorable conditions with the choice, as far as making holes and riveting is concerned, following the order of preference given above.

Where semi- automatic machines need a given set-up (such as Erco and Chicago riveters) use may be confined to one type and size of rivet. If other odd sizes are needed they may be hand-inserted and driven by a slower machine, for the time for changing set-ups on semi-automatic machines to handle different rivets has to be considered. For similar reasons, an occasional odd-size hole may be drilled rather than pierced if it is faster to use a light electric drill than to change a punch and die.

A line of this type naturally requires proper planning to operate with maximum advantage. In the Martin plant where

(*Turn to page* 262)

Pierced holes, in locations where Ercos cannot be used, are usually punched in tubular rivet and stud machines. Assembly is located (1) by sleeve surrounding punch below work and fitting holes in Masonite jig, as shown; or (2) by spray spots brought into position under light beam from projector lamp attached to head of press. Note proximity of conveyor belt at operator's right.

Load Characteristics Of Cellulose Acetate Plastic

PART II

By **WILLIAM N. FINDLEY,** *Assistant Professor of Theoretical & Applied Mechanics, College of Engineering, University of Illinois*

Changes in strength and resistance of this material caused by age, torsion and moisture are considered in this second article of Mr. Findley's significant series.

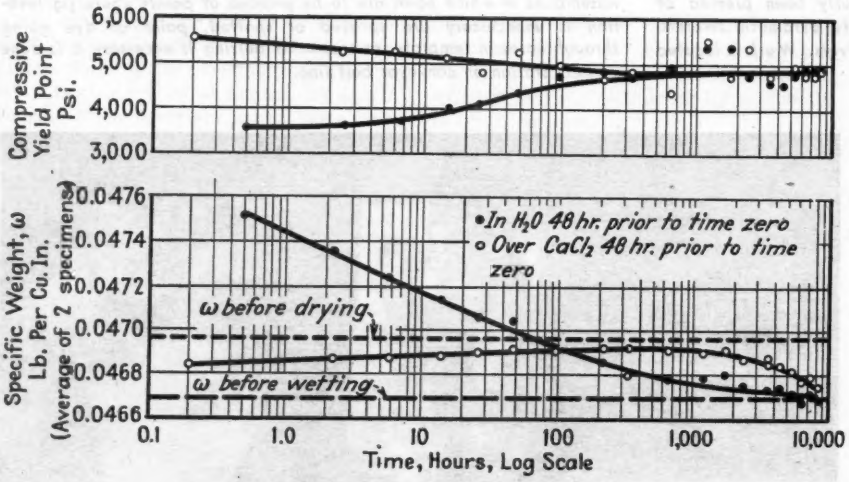


Fig. 10. Effect of time and conditioning on yield point in compression and specific weight vs. time elapsed.

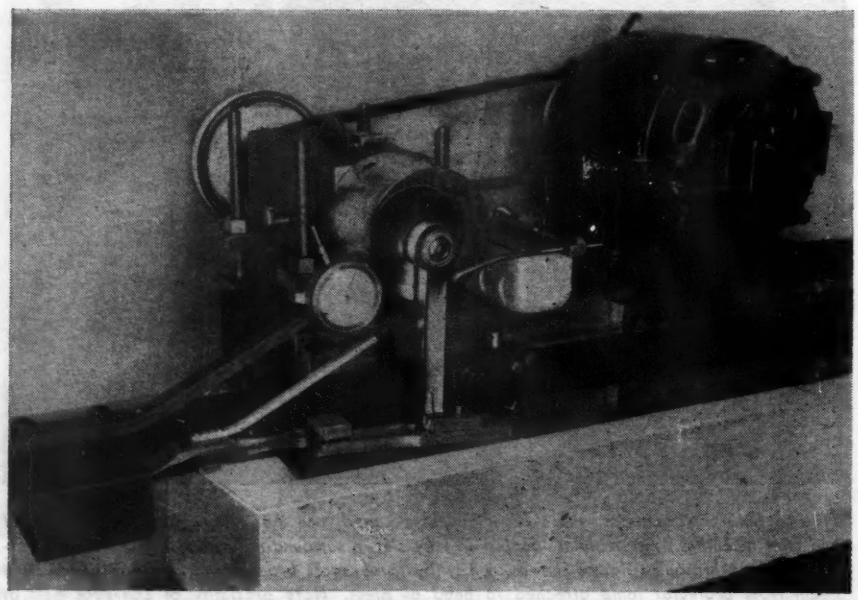


Fig. 11. Fatigue machine of repeated-bending constant-amplitude type.

HAVING DISCUSSED the various properties of cellulose acetate, we now proceed to describe the actual experimental tests.

Fifty specimens were machine treated as follows: Twenty-five of them were immersed in water for a period of 48 hr., then removed to a rack, where they remained until tested. The other 25 were placed in a desiccator over anhydrous calcium chloride for a period of 48 hr., removed, and placed on a rack. Both groups of specimens were then stored in the testing room (at constant temperature and relative humidity) for the duration of the tests.

Two from each group were set aside as control specimens, and their weight and length were recorded, both before conditioning and at intervals after treatment. The remaining specimens were tested in compression at intervals over one year. One specimen was tested immediately after removal from the water bath and another immediately after removal from the desiccator. The others were tested at specific intervals to give a uniform distribution of data when test results were plotted against the logarithm of the time elapsed after removal from the conditioning medium. All tests were run at a no-load head speed of 0.06 in. per min. This resulted in a rate of strain of about 0.002 per min.

It was observed that a definite yield point in compression existed for cellulose acetate plastic. This was determined by the fact that the load remained constant for a period during the test. Since fracture did not occur during compression, the yield point was used to measure the effect of moisture on strength. In Fig. 10, the compressive yield point for these tests is plotted against elapsed time.

It was observed that about 1½ mo. (1,000 hr.) was required for the compressive yield point to approach a stable value, and it is significant that the final value of compressive yield point was nearly the same for both the moistened and dried specimens. Some scatter in these data was observed, due in part to the fact that the air conditioning of the laboratory was interrupted for 4 or 5 hr. on two or three occasions.

In the lower part of Fig. 10 is shown the average specific weight of the two control specimens, plotted against time. These control specimens were weighed and measured at the same time that tests of the others were made. Data in Fig. 10

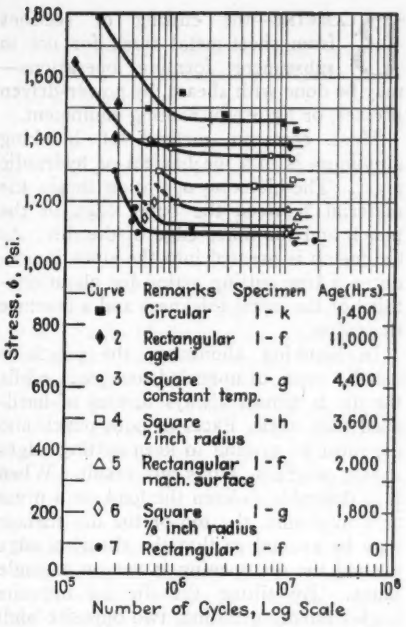

Stress, σ, Psi.
Number of Cycles, Log Scale
Curve Remarks Specimen Age(Hrs)
1 Circular 1-k 1,400
2 Rectangular aged 1-f 11,000
3 Square constant temp. 1-g 4,400
4 Square 2 inch radius 1-h 3,600
5 Rectangular mach. surface 1-f 2,000
6 Square ⅞ inch radius 1-g 1,800
7 Rectangular 1-f 0

Fig. 12. Stress vs. cycles tests (σ-N) for different shapes of specimens.

indicate that about one month was required for the specific weight to return to the value obtained before conditioning was started. No explanation is offered for the fact that specific weight of initially dry specimens decreased after 7,000 hr., unless perhaps the specimen was losing plasticizer.

No appreciable change in length was observed as a result of the above treatment. Wet specimens decreased about 0.4 percent in length during the testing period, while no measurable change in the dried specimens was observed.

Fatigue tests were conducted on the repeated-bending constant-amplitude fatigue machine, equipped with a V-belt drive to provide variable speed. In this machine (see Fig. 11) the specimen was repeatedly bent back and forth as a cantilever beam by a variable eccentric. Procedure was as follows: The bending moment M corresponding to the desired stress σ was computed from the equation $M = \sigma I/C$.

Maximum force exerted by the connecting rod on the specimen holder was determined by dividing the bending moment by the moment arm. Deflection required to produce this force was determined by calibrating the specimen itself as a dynanometer, while deflection under load was measured by a dial gage. In a few of the tests a dynanometer (Fig. 11) was used to measure the applied force. An adjustment also was provided to permit changes in the range of stress of the stress cycle. For example, in the first series the mean (or average) stress was zero—the stress being completely reversed.

In a later series of tests the mean stress was 2,000 psi., and the amplitude of the alternating stress was 1,100 psi., so that in this case the range was from 900 psi. to 3,100 psi. The number of cycles was recorded on a mechanical counter and a toggle switch was arranged to stop the machine when the specimen fractured. Thus for each specimen in the machine, stress corresponding to deflection during the test was calculated from the bending moment measured while at rest, and the number of cycles for fracture was obtained.

These data were then plotted with stress as ordinates and number of cycles as abscissa using semi-logarithmic plotting. For cellulose acetate a well-defined endurance limit was found. The endurance limit is defined as the alternating stress cycle maximum amplitude which will not cause fracture for an indefinitely large number of stress cycles.

In Fig. 12, $\sigma - N$ (stress vs. cycles) diagrams are plotted for tests of specimens having several different shapes: Curve 1, a circular cross section specimen shown in Fig. 1k (see page 146, June AVIATION), curve 7, a rectangular specimen; Fig. 1f; curve 6, a square specimen; Fig. 1g of ⅞ in. radius; and curve 4, a square cross section of 2 in. radius. The endurance limit for these tests is shown in the third column of our accompanying Table I. It was found by re-tests of the same material (after a lapse of 1 yr. 3 mo.) that the endurance limit increased with age. The $\sigma - N$ diagram for specimens aged 11,000 hr. is shown in curve 2 of Fig. 12. Comparing this endurance limit—1,380 psi. with 1,100 psi. for the same shape tested 11,000 hr. earlier—it was found that the limit had increased about 25 percent in 11,000 hr. (about 15 mo.).

In order to compare data obtained at different periods, the endurance limit for several shapes tested was adjusted approximately to the value which was obtained at an age of 11,000 hr. (measured from the time of the original test). The adjustment was made on the assumption that the change of limit with time was nearly a linear function during the interval. The age as defined above for each set of tests is shown in column 4, Table I, and the endurance limit adjusted to an age of 11,000 hr. is shown in column 5.

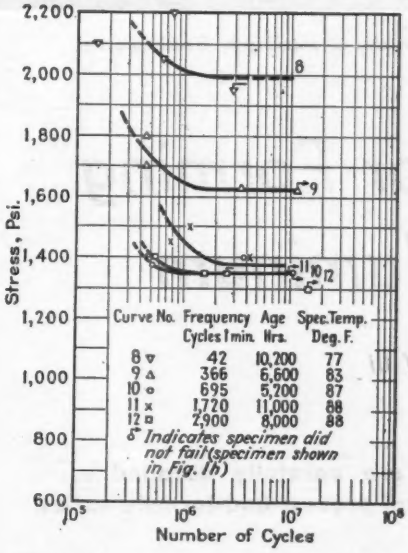

Stress, Psi.
Number of Cycles
Curve No. Frequency Cycles/min. Age Hrs. Spec. Temp. Deg. F.
8 ▽ 42 10,200 77
9 △ 366 6,600 83
10 ○ 695 5,200 87
11 × 1,720 11,000 88
12 □ 2,900 8,000 88
δ Indicates specimen did not fail (specimen shown in Fig. 1h)

Fig. 13. Diagram of σ-N for several testing frequencies.

TABLE I—Endurance Limits for Different Shaped Specimens

Curve No.	Specimen	End limit (measured) p.s.i.	Age hr.	End limit at age 11,000 hr. (calculated*) p.s.i.
1.	Circular, Fig. 1k	1,450	1,400	1,760
2.	Rectangular, aged Fig. 1f	1,380	11,000	1,380
3.	Const. temp., Fig. 1g	1,350	4,400	1,540
4.	Square, 2-in. rad., Fig. 1h	1,250	3,600	1,440
5.	Machined, Fig. 1f	1,175	2,000	1,410
6.	Square, 7/8-in. rad., Fig. 1g	1,120	1,800	1,350
7.	Rectangular, Fig. 1f	1,100	0	1,380
(Not Shown)	V-Notch (not shown)	550	1,000	670

These values were obtained by correcting all endurance limits to the value which would be found if tested at an age limit of 11,000 hr. The correction was based on an assumption that the endurance limit increased linearly with time. Rate of increase was found from curves 2 and 7.

Comparing different shapes of specimens by means of column 5, it was found that the square specimen with ⅞ in. radius had nearly the same endurance limit as the rectangular. The square specimen with 2-in. radius had an increase of about 4 percent, whereas the circular cross section specimen had an endurance limit markedly higher than any of the other two shapes, showing an increase of about 27 percent over that for the rectangular specimen. Reason for this is not known, though a similar effect has been observed in some metals and not in others. The phenomenon may be associated, in part, with the quantity of material subjected to high stress, compared to the quantity immediately adjacent to high stress material available to receive additional stress, resulting from the redistribution of stress after a minute crack has formed.

The notch "sensitivity" of cellulose acetate in flexural fatigue was obtained from fatigue tests of rectangular specimens having a V-notch machined across one face. The notch used had a 45 deg. included angle with a 0.01 in. radius at the bottom. The depth of the notch was 0.02 in. The endurance limit obtained for the notched specimens was 670 psi. when adjusted to age at 11,000 hr. This value represents a decrease of about 53 percent from that of the rectangular sample having a machined surface (discussed below). The effective stress con-

(*Turn to page* 263)

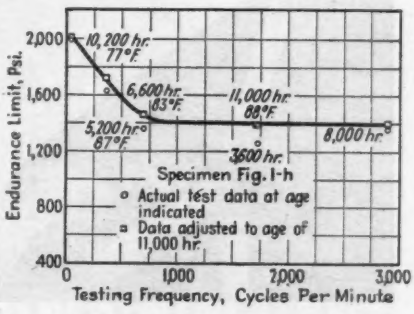


Fig. 14. Effect of speed of testing on endurance limit.

Rubber mats are placed over dies in first step of blanking by Guerin process.

Methods for Forming Sheet Aluminum

PART III

Here, blanking and piercing are carefully detailed . . . Final installment of this practical process-and-formula series.

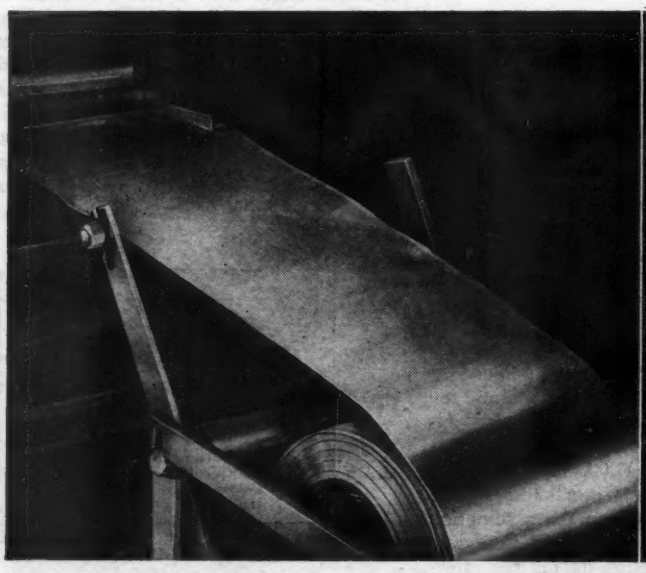
BLANKING—the cutting of sections from sheet-metal stock for use in subsequent forming operations—may be done with shears, by power-driven presses, or by use of routing equipment.

Most common method of blanking aluminum is in a mechanical or hydraulic press. The blanking operation shears the material between the outer edge of the punch and the inner edge of the die. As the punch is pressed into the stock it produces a true cutting action for about one-third of the metal thickness and a fracture thereafter.

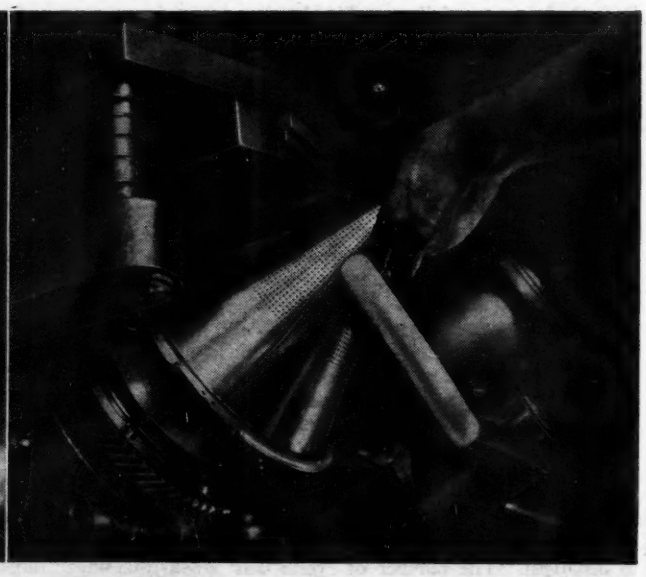
In blanking aluminum, the punch is usually made of annealed tool steel, while the die is almost always formed of hardened tool steel. Faces of both punch and die must be ground to keep cutting edges sharp, otherwise burrs will result. When it is desirable to keep the load on a press at a minimum, the top of the die surface may be ground so that the shearing edge around the die opening is not on a single plane. By tilting the die on opposite angles during grinding, two opposite high points are ground on its face, which should differ from the low points by at least half the thickness of the material, but preferably the full thickness. If the blanks must be kept flat, the punch should be ground flat regardless of high and low points on the die surface.

Correct clearance between punch and die is determined by the type and thickness of the sheet to be blanked. If clearance is too great, blank will be "broken out" rather than sheared. If too small a clearance is used, tools will be excessively strained. Improper clearance produces rough blanks, is hard on tools, and requires more power. Table I shows clearances between punch and die for blanking aluminum alloys. In general, a clearance equal to one-eighth the thickness of the sheet will prove sufficient.

The walls of the die opening should be tapered away from the cutting edge 3 to 5 deg. to permit the blank to drop through



When thin sheet (under 1/16-in. thick) is fed from coils into press, it is automatically lubricated by swab.



Cone has been perforated on this horn press. Automatic index revolves work to give equal spacing of holes.

Routing machines with swinging cutter can cut many sheets in single operation.

easily. There is a tendency for the sheet to cling to the punch on its up-stroke unless a stationary stripper is attached to the die or a spring stripper is attached to the punch.

It is important that the designer lay out the work to assure the least possible waste. Table II shows the recommended scrap on the sides and between blanks for various gages and diameters.

Danger of shearing or scoring the punch is great unless there is some means of aligning it accurately with the die. The time required, as well as maintenance cost, can be lessened by mounting punch and die in a leader pin die set.

Both the sheet to be blanked and the cutting edges of the tool should be generously lubricated to keep maintenance costs down and to cut the blanks smoothly. A medium grade engine oil, plus a little fatty oil diluted with kerosene, is best for the harder or thicker sheets of aluminum. For softer alloys and tempers, dilution of the mixture is not necessary.

The sheet may be lubricated by hand brushing, or by passing it through saturand felt pads. Thin coiled sheet is usually fed into the press automatically on feed rolls. The metal, before entering the die, passes through oily pads which are attached directly to the press bed. A saturated ring of felt above the stripper will lubricate the punch by permitting the oil to trickle over its edge.

Where necessary to maintain bright

(*Turn to page* 264)

Blanking Table I—Punch and Die Clearances

(t = thickness of sheet, inches)

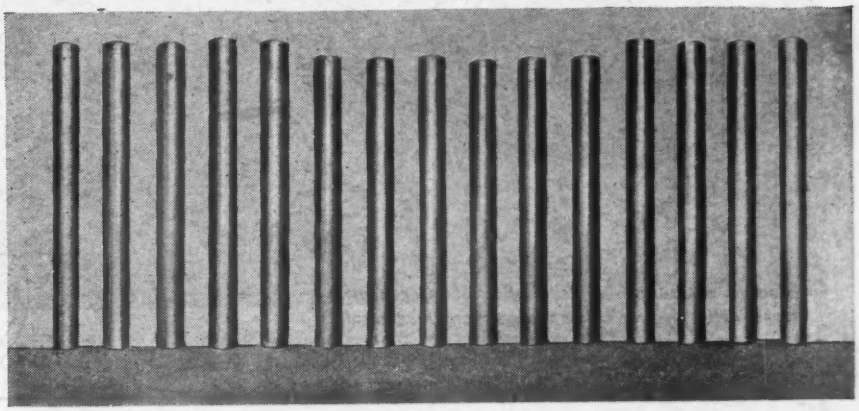
Aluminum sheet alloy	Clearance		Aluminum sheet alloy	Clearance	
	On a side	On the diameter		Side	On dia.
2SO.....	0.10t	0.20t	24SO	0.13t	0.26t
2S½H.....	0.12t	0.24t	24ST	0.16t	0.32t
2SH.....	0.14t	0.28t			
			52SO	0.13t	0.26t
3SO.....	0.10t	0.20t	52S½H	0.14t	0.28t
3S½H.....	0.12t	0.24t	52SH	0.15t	0.30t
3SH.....	0.14t	0.28t			
			61SO	0.11t	0.22t
17SO.....	0.13t	0.26t	61SW	0.12t	0.24t
17ST.....	0.16t	0.32t	61ST	0.14t	0.28t

Blanking Table II—Scrap Allowances

Gage	Blank dia. in.	Scrap on side, in.	Scrap between blanks, in.
No. 28g. (0.013 in.).....	0 to 10 incl.....	1/8	1/16
to	10 to 20 incl.	3/16	3/32
No. 15g. (0.057 in.) incl..	20 to 30 and over	1/4	1/8
No. 15g. (0.057 in.).....	0 to 10 incl.	5/32	3/32
to	10 to 20 incl.	7/32	1/8
No. 12g. (0.081 in.) incl..	20 to 30 and over	5/16	5/32
No. 12g. (0.081 in.).....	0 to 10 incl.....	3/16	1/8
to	10 to 20 incl.	1/4	5/32
No. 8g. (0.128 in.) incl..	20 to 30 and over	3/8	3/16

When many holes are to be punched at one time, punches should be stepped to prevent all entering metal at one time.

Single-action press is used to pierce holes in fabricated parts. (All photos by Aluminum Co. of America.)



Electronics Smooth Supercharging

How a new, sensitive supercharger control substitutes precise electronic impulses for the manual control by the overly busy pilot.

THE DEMAND for increased engine power and efficiency at great altitudes has rendered the turbosupercharger a necessity for high-flying combat.

Design problems—as compared to those faced by the stationary turbo-compressor engineer—are extremely complicated, both because of the great range of atmospheric pressures and temperature to be considered and also because the problems of pilot, who is frequently far too occupied with combat problems to be able to give his power plant controls the attention required for best efficiency.

For these reasons, some kind of automatic control is essential in order that the pilot may have maximum power when he requires it, even though he is momentarily prevented from checking either his engine or the instruments which tell him how it is performing.

The turbosupercharger itself is a simple exhaust-driven turbine, directly coupled to a centrifugal compressor or impeller which compresses atmospheric air to the pressure predetermined by the pilot.

This compressed air undergoes a considerable rise in temperature, making necessary an intercooler to extract much of the heat of compression before the air proceeds to the carburetor and internal gear-driven blower which delivers it to the engine cylinders.

Minneapolis - Honeywell's electronic turbo control system automatically regulates the output of all superchargers on multi-engine planes by means of a central boost selector operating through amplifiers which boost inverter current on its way to the waste-gate motors. These motors open or close the waste gates, which permit more or less of the engine exhaust gas to reach the atmosphere without first operating the turbine which drives the supercharger. Operation of the waste gate motor is controlled by electrical signals from the turbo boost selector, the Pressuretrol, and the turbo governor.

Air pressure of the supply from the supercharger to the carburetor is regulated by the Pressuretrol using two bellows to operate a potentiometer.

Waste-gate motion is controlled by the turbo amplifier, which translates the signals received from the other units into motor action, either to close or open the waste gate and thus regulate the speed of the turbine and with it, the delivered air pressure.

Great operational advantages can be obtained from the use of a device, such as this, which substitutes sensitive electronic controls for slower human reactions and subsequent manual operations. In addition to being fully automatic and accurate within a very small degree, this equipment minimizes the probability of inexperienced or overstressed pilots setting up excessive manifold pressures, with resultant damage to their engines.

Because the safety margin between safe operating speeds and dangerous ones is extremely narrow, a suitable control will permit higher output without liability of damage through overspeeding the turbine.

Another advantage of this type of equipment is its successful operation under subzero conditions, which do not affect the action of electronic controls.

Through almost instantaneous power control through regulation of exhaust pressure by means of the waste gate, engine speed control is simplified, since boost change gives better regulation than throttle operation. Meantime, hand-throttle control is at no time interfered with, so the pilot may, if he desires, use the manual method for varying the speed of his plane.

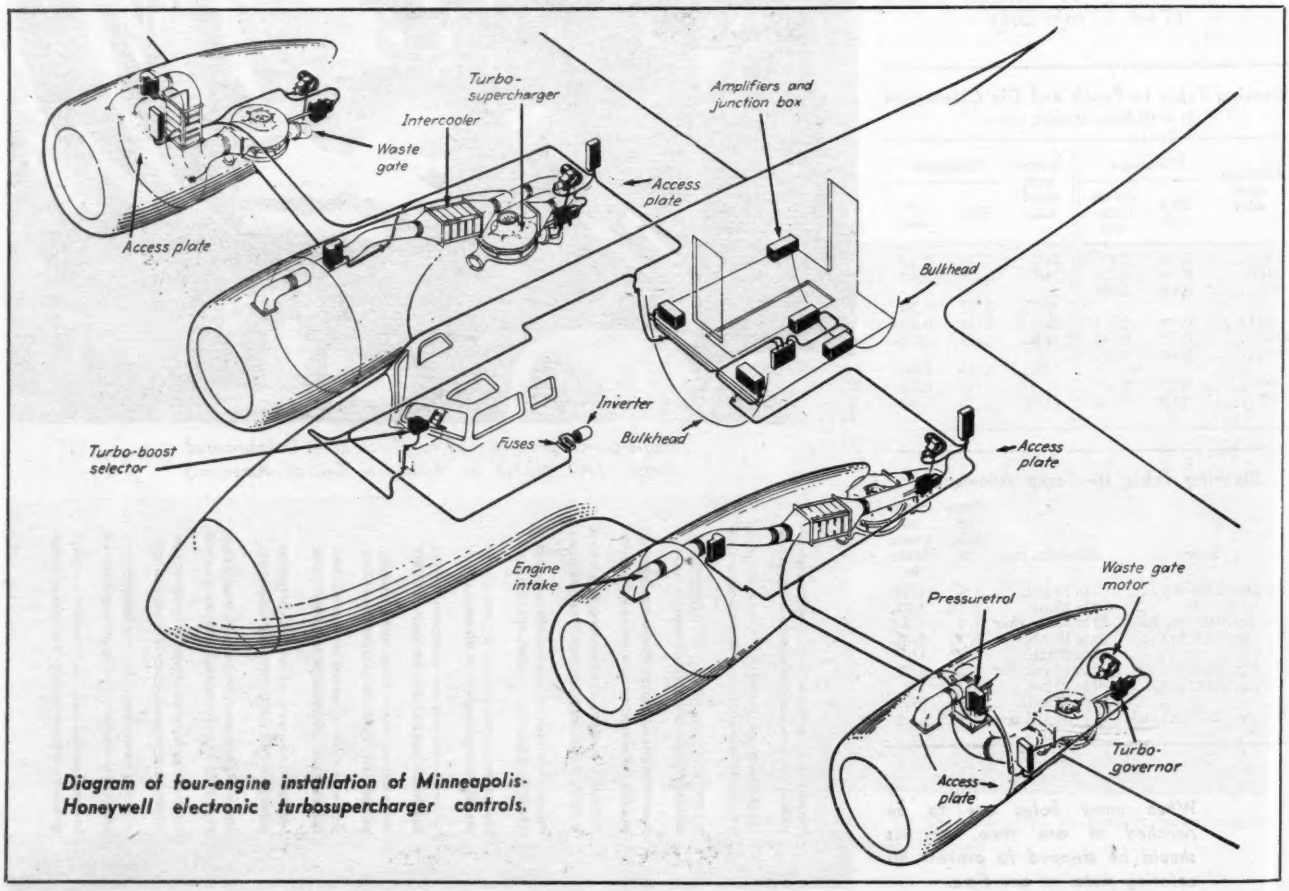


Diagram of four-engine installation of Minneapolis-Honeywell electronic turbosupercharger controls.

CONVAIR CLASSES "BROADEN THE SPECIALISTS"

By H. L. WHEELER

Chief Group Engineer, Armament, Consolidated Vultee Aircraft Corp., Ft. Worth, Tex.

Engineers teach engineers and instructors learn from their students in this unique plant school instituted to widen the knowledge of "the man who knows more and more about less and less."

CONSOLIDATED VULTEE Aircraft engineers are again going to school to add postscripts to the engineering degrees and "sheepskins" tucked away in their trunks.

Expert in their own special fields, the engineers are now attending semi-weekly classes where they get opportunities to peer beyond the barriers of specialization by discussing what's happening in the other fields of aircraft engineering.

Producing an airplane has become a job of specialization, hence as development of airplanes broadened, study of their component parts became channelized into narrower and narrower fields. Complexity of the modern airplane makes it virtually impossible for any one person to have an over-all knowledge of the many specific tasks of its engineering, and so specialization resulted.

The Convair classes sprang from a growing realization that the specialists—while perhaps working side-by-side—increasingly were losing perspective of the over-all technical functions of the other parts on the plane.

In addition to broadening the personnel's acquaintance with the general developments in aircraft engineering, the school is also utilized to introduce specific new design methods and to instruct regarding new materials, equipment, and processes. Net result is a shorter time lag between the introduction of a new idea and its incorporation in the building of the airplane.

Wide List of Subjects

At Convair's Fort Worth division, 55 subjects have been, or are in the process of being, discussed. This list, covering the field of aircraft engineering, includes such subjects as cockpit arrangements, general hydraulics, levered suspension and caterpillar landing gears, propeller controls, soundproofing, anti-icing, and blind landing equipment, each presented by a specialist.

Where the opportunity offers, particularly in the introduction of a new idea, experts from outside are brought to address the classes.

The speed with which ideas may be "sold" through this method underscores the obvious advantages of a visual and auditory presentation over the standard method of utilizing a memorandum.

Each subject leader prepares a discussion which can be presented in approximately one-half hour. While the subject leader is supposed to do most of the talking, engineers are making liberal use of their right to comment, to ask questions, or perhaps to argue a statement.

The group is broken into three sections. As a result, leaders present their topic on three successive days. While the same discussion may be presented at each of the three sections, questions raised at the first usually mean development of additional discussion material for the second section. And answers to questions raised at the second session are also included in the discussion for the third.

The speakers' reactions have been as beneficial as those of the engineers attending the classes. For it has been brought out that, while the topic leader may have a good knowledge of his subject, he meanwhile may have somewhat lost sight of various prior-functional or post-functional details. Hence, the subject leader "goes back to school" himself in presenting his material to other engineers.

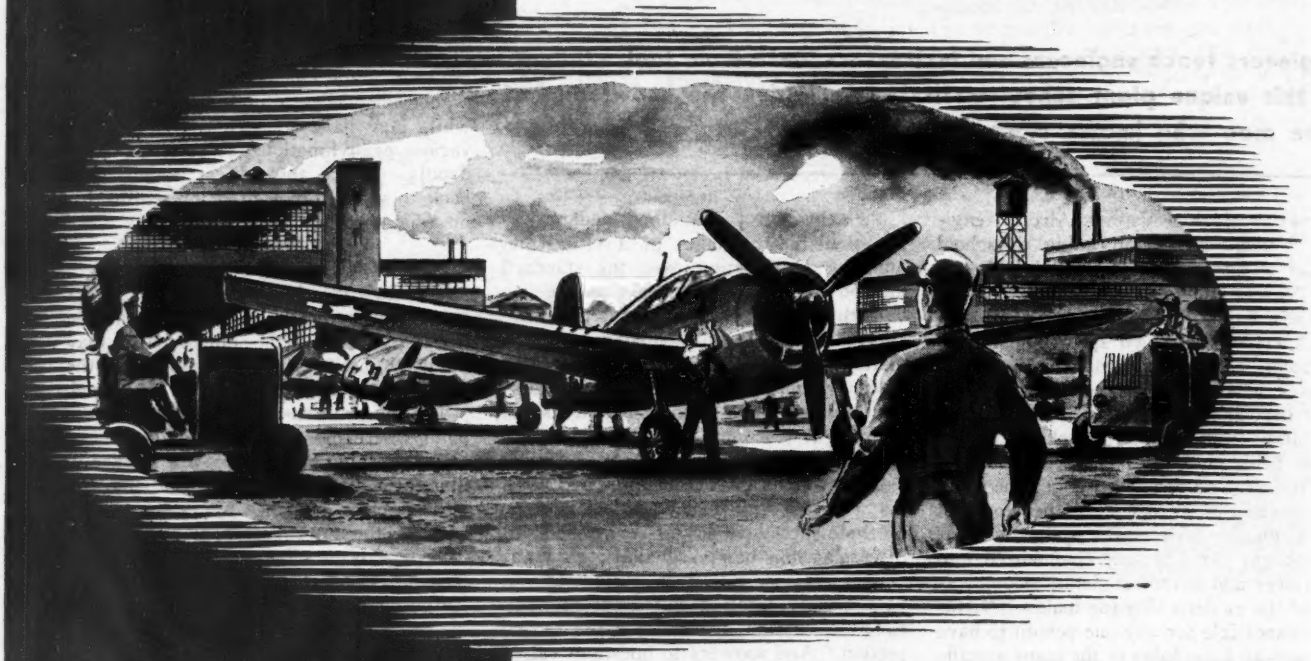
Training Aids Used

The class idea has been received favorably in every instance by the engineers, and if discussion of the subject matter may be taken as a criterion, interest in the series is certainly running at a high level.

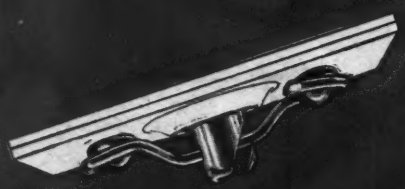
The program has been developed to the point where models, charts, diagrams, or actual working mechanisms are utilized in illustrating the discussions. Initially, the classes were launched on a temporary basis at the Fort Worth plant, but they have now been adopted on a similar pattern at Convair's San Diego division. Enthusiasm for the idea indicates it will likely be continued indefinitely and on a constantly broader scale.

Convair's engineer's go to school to keep up with latest developments in the other man's department.

There is no shortage of DZUS* FASTENERS



Dzus—the most widely used fastener in the aviation industry. Only ¼ turn to lock or unlock.



Flush head type showing side view.

End view showing unique spring design.

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Here at Dzus our business has always been to make the best fastener in the world. Long before the war, that was true. The Dzus Fastener was designed to meet a pressing need in the aircraft industry, and over the years it has proven its worth by keeping pace with new developments. The Dzus is no longer an experiment, but a time-tested product. Relentless research to meet the ever more exacting requirements has developed The Dzus – so that it has literally grown up with the aircraft industry.

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DZUS TRADE MARK FASTENER CO., INC.

BABYLON, NEW YORK

How to Get Top Efficiency From Your Vacuum Pumps

Detailed here are Pesco's precise methods of installing and maintaining these essential units—and instructions are provided for building a suitable test bench.

NOTE FIRST that installation instructions for Pesco vacuum pumps should only be used as a general guide, for problems vary with different plane designs.

Initial step is to remove shipping plugs from inlet and outlet ports before turning pump coupling. Next remove cover plate and gasket from engine pump pad and then wipe clean, noting carefully direction of rotation of engine drive gear. Refer to arrows on machined surface on rear of pump and determine which is intake port. Test pump for freedom of operation by turning with fingers. If pump is intended for lubrication through mounting pad, check oil holes to insure free passage.

If pump is equipped with hex head plugs next to mounting flange, make sure that plug marked "suct" is installed on same side as intake. Interchange the two plugs if necessary, and tighten and secure with safety wire.

Place gasket over mounting flange, making sure that it does not block hole in pad if pad lubrication is employed. Mount pump in most desirable position for air line connection, then tighten mounting nuts evenly and safety wire. If external oil lines are to be used, block holes in pad by turning gasket.

Install suction and discharge lines to pump ports. Inlet port for either rotation is designated by arrows on exterior surface next to cover. Tighten all connections and see that tubing is properly supported and bonded.

If engine has oil ducts to mounting pad and pump has oil holes, no further provision for lubrication is necessary; otherwise, an external oil line must be installed. Either system must be tested before installation is complete. Probe oil passages to make sure they are free from obstruction.

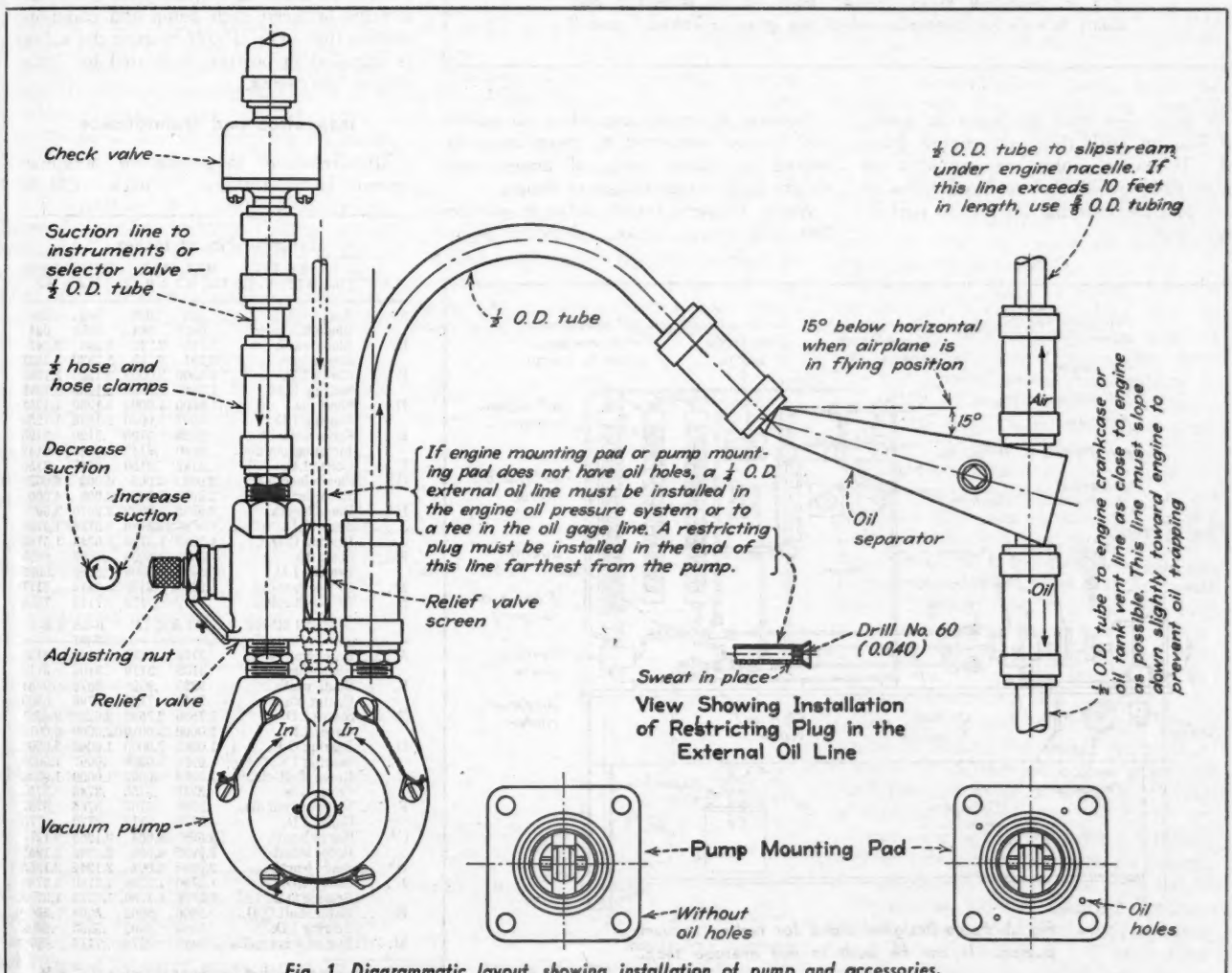

Check valve
Suction line to instruments or selector valve — ½ O.D. tube
½ hose and hose clamps
Decrease suction
Increase suction
Adjusting nut
Relief valve
Vacuum pump
In
In
½ O.D. tube
If engine mounting pad or pump mounting pad does not have oil holes, a ¼ O.D. external oil line must be installed in the engine oil pressure system or to a tee in the oil gage line. A restricting plug must be installed in the end of this line farthest from the pump.
Relief valve screen
Drill No. 60 (0.040)
Sweat in place
View Showing Installation of Restricting Plug in the External Oil Line
¼ O.D. tube to slipstream under engine nacelle. If this line exceeds 10 feet in length, use ⅜ O.D. tubing
15° below horizontal when airplane is in flying position
15°
Air
Oil separator
Oil
¼ O.D. tube to engine crankcase or oil tank vent line as close to engine as possible. This line must slope down slightly toward engine to prevent oil trapping
Pump Mounting Pad
Without oil holes
Oil holes

Fig. 1. Diagrammatic layout, showing installation of pump and accessories.

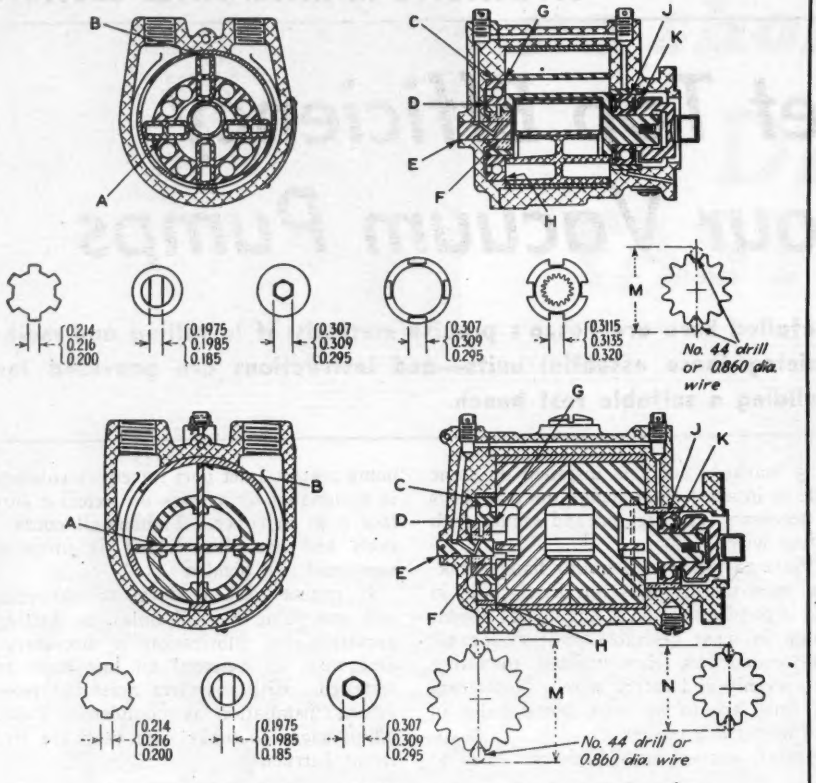


Fig. 2. Sectional views showing parts to be inspected and points to note for tolerances, which are given in Tables 1 and II.

Be sure also that oil holes in pump pad line up with those on engine drive pad. If no oil holes are provided on engine pad, turn gasket to block holes in pump and use external oil line to port in pump body.

Because of engine vibration, all valves and fittings connected to pump must be braced to relieve pump of unnecessary weight and prevent failure of flange.

Relief Valve: Install valve in suction line near pump intake. Between pump and valve install 6 in. to 24 in. length of tubing, using hose connections and pipe nipples. Mount valve with screen facing *downward or to one side, never upward.* Screen should be easily accessible for inspection or cleaning.

Oil Separator: Install separator in pump discharge line. Mounting brackets or tubular mounting supports will give proper angle. Some larger separators have cushions on sides to minimize vibration. Mounting at specified angle is essential for proper operation.

Safety valve is installed in discharge line after oil separator, using 6 in. to 12 in. tubing with pipe fittings so that valve guide assembly can be easily removed for inspection or cleaning.

Check valve, installed in pump suction line to protect instruments from momentary back pressure from engine backfire, also acts as safety valve in multi-engine installations where, if pump fails, valve closes off line so that leakage cannot render rest of system inoperative. In *3V-226 series,* the valve is a spring-loaded disk in an aluminum housing with hose connections; in *3V-311 series,* the valve is a two-piece swing-gate type in two-part housing with pipe tapped ports.

Either check valve can be installed in the suction line, using rubber tubing and hose clamps or pipe-tapped hose nipple. Make sure arrow on valve points toward pump. In twin-engine installations, install a valve between each pump and common suction line. On *3V-311* be sure the valve is installed in position indicated by "this side up" on casing.

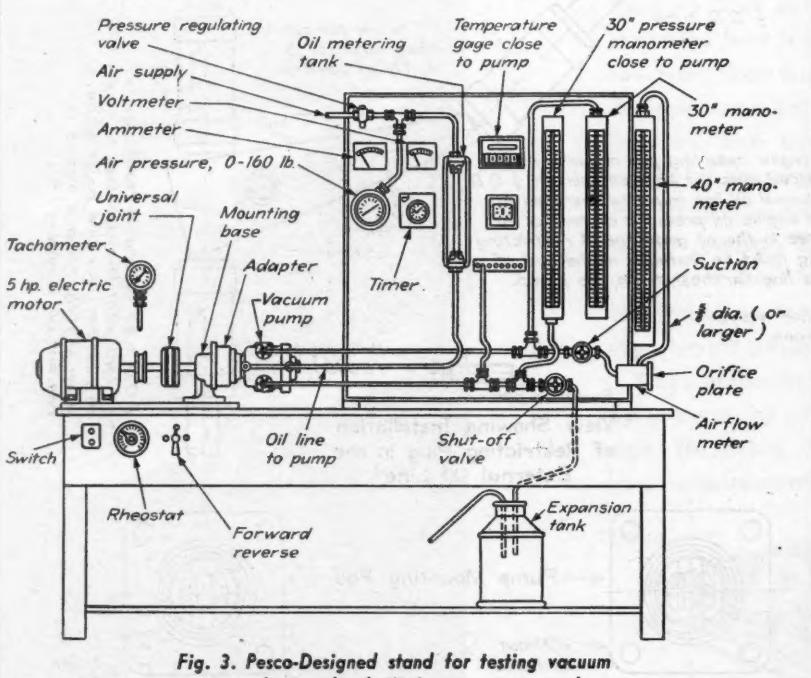


Fig. 3. Pesco-Designed stand for testing vacuum pumps. It can be built in any average shop.

Inspection and Maintenance

Hundred-hour inspection of pumping system is as follows: *Pump.* Check

Table I—Fits in Inches

LET	PART FIT Models 3P207–211	MIN.-MAX. B-3, B-7 & B-12		WHEN NEW B-4 & B-8	
A.....	Rotor slot	.095	.096	.095	.096
	Blade thickness	.0933	.094	.0933	.094
B.....	Blade width	2.744	2.747	3.244	3.247
	Sleeve bore	2.751	2.753	3.2530	3.2532
C.....	Sleeve I.D.	2.0000	2.0005	2.1250	2.1255
	Bearing O.D.	1.9997	2.0000	2.1235	2.1245
D.....	Shaft dia.	1.0000	1.0003	1.1250	1.1253
	Bearing I.D.	.9997	1.0000	1.1246	1.1250
E.....	Cover hole	.3120	.3125	.3120	.3125
	Metering pin dia.	.3140	.3142	.3140	.3142
F.....	Collar I.D.	.3147	.3150	.3147	.3150
G*....	Sleeve length	3.003	3.004	4.002	4.003
	Rotor length	2.9995	3.0000	3.999	4.000
H*....	Blade length	2.9995	3.0002	3.9970	3.9977
J.....	Sleeve I.D.	1.3780	1.3786	1.5748	1.5754
	Bearing O.D.	1.3775	1.3780	1.5743	1.5748
K.....	Shaft dia.	.5906	.5908	.6693	.6695
	Bearing I.D.	.5903	.5905	.6690	.6693
M....	16 Tooth spline	.9114	.9177	.9114	.9177
N.....	12 Tooth spline	.7112	.7174	.7112	.7174
	Model 3P-194	B-1 & B-1A		B-2A & B-6	
A.....	Rotor slot	.3128	.3135	.3128	.3135
	Blade thickness	.3105	.3112	.3105	.3112
B.....	Blade width	.9991	.9996	.9679	.9684
	Center pin dia.	.7440	.7445	.6795	.6800
C.....	Sleeve I.D.	2.7530	2.7535	2.6280	2.6285
	Cover I.D.	2.0000	2.0010	2.0000	2.0010
D.....	Bearing O.D.	1.9995	2.0000	1.9995	2.0000
	Bearing I.S.	.9997	1.0000	.9997	1.0000
E.....	Rotor shaft dia.	1.0000	1.0003	1.0000	1.0003
	Cover hole	.3745	.3750	.3745	.3750
F.....	Metering pin dia.	.3765	.3767	.3765	.3767
	Collar I.D.	.3772	.3775	.3772	.3775
G*....	Sleeve length	3.003	3.004	2.1265	2.1275
	Rotor length	2.9995	3.000	2.1245	2.1255
H*....	Blade length	2.9995	3.002	2.1242	2.1255
J.....	Sleeve I.D.	1.3780	1.3786	1.3780	1.3786
	Bearing O.D.	1.3775	1.3780	1.3775	1.3780
K.....	Rotor shaft O.D.	.5906	.5908	.5906	.5908
	Bearing I.D.	.5903	.5905	.5903	.5905
M....	Engine drive spline	.7112	.7174	.7112	.7174

* Use gaskets as required for proper clearance at G & H.

Table II—Clearances in Inches

LET	3P-194 B-1 & B-1A	B-2A & B-6	3P207-211 B-3, 7, 12	B-4 & B-8
A.....	.0016	.0016	.001	.001
	.003	.003	.0027	.0027
	.003*	.005*	.003*	.004*
B.....	.0093	.0112	.004	.006
	.0113	.0132	.009	.0092
	.015*	.015*	.001*	.011*
C.....	.0000	.0000	.0000	.0005
	.0015	.0015	.0008	.002
	.002*	.002*	.0025*	.0025*
D.....	.006T	.0006T	.0006T	.0007T
	.0000	.0000	.0000	.0000
	.001*	.001*	.001*	.001*
E.....	.0022T	.0015T	.0022T	.0022T
	.0015T	.0015T	.0015T	.0015T
F.....	.0005	.0005	.0005	.0005
	.001	.001	.001	.001
	.0015*	.0015*	.0012*	.0012*
G.....	.0015	.0015	.0015	.0015
	.0025	.0025	.0025	.0025
	.007*	.007*	.007*	.007*
H.....	.0015	.0015	.0015	.0015
	.0025	.0025	.0025	.0025
	.007*	.007*	.007*	.007*
J.....	.0000	.000	.0000	.0000
	.0011	.001	.0011	.0011
	.0025*	.0025*	.0025*	.0025*
K.....	.0005T	.0005T	.0005T	.0005T
	.0001	.0001	.0001	.0001
	.001*	.001*	.001*	.001*

*Maximum wear. T Tight.

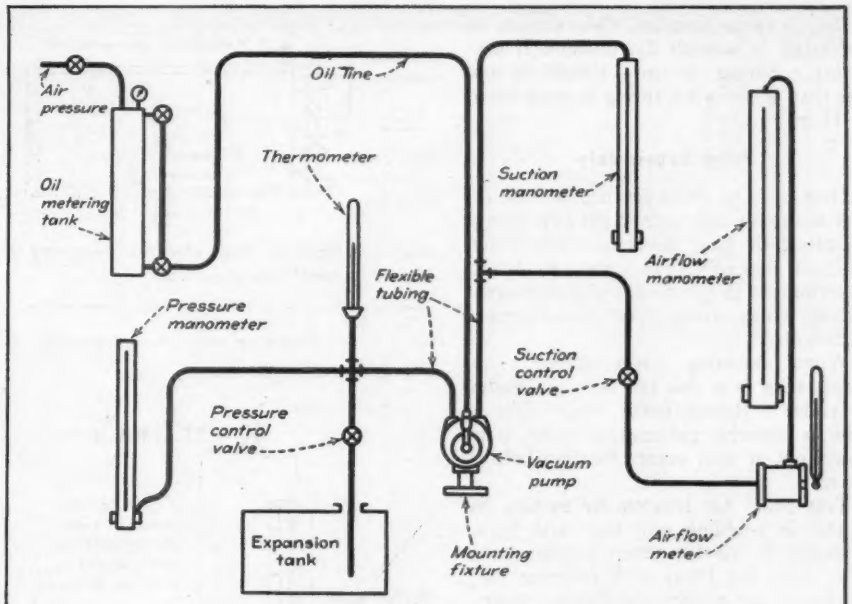


Fig. 4. Diagrammatic layout of test stand with connections.

security of mounting and possible leaks in air lines. *Relief Valve.* Examine screen and if it is dirty remove valve and loosen screen assembly with wrench. Clean with gasoline. Valve is properly adjusted when shipped. If necessary to alter adjustment, loosen locknut and turn adjusting nut counter-clockwise to increase suction, or clockwise to decrease it.

Safety valve. Remove valve guide and wash in suitable cleaning fluid. If disk is worn, smooth carefully on flat oilstone. Test spring tension by measuring the force required to compress to 1⅛ in. Force must be at least 3.7 lb.

Oil separator with removable screen. Remove oil screen and outlet fitting, clean and wash unit in suitable cleaning fluid, drying afterward with compressed air. (For type without removable screen, remove entire unit and wash out thoroughly in cleaning fluid.)

Check Valve. Remove and disassemble at engine overhaul periods, and examine bakelite disk and dress lightly on smooth oilstone, if required. If disk is badly worn, replace with new one. When reassembling, make sure gasket will still provide effective seal.

Coupling. If wear is shown or it has failed, remove snap ring, extract coupling, and replace with new one.

All vacuum pumps must be thoroughly lubricated internally and externally as protection against corrosion before being stored. Pour several cc. of SAE 30 oil into one port. Turn coupling several times to insure complete lubrication. Install shipping plugs tightly in ports to prevent leakage. Coat all external parts (likely to become corroded) with light grease.

Overhaul

Overhaul should be undertaken only where complete facilities for repair and testing are available. Pumps can be readily disassembled without special tools, and removal of cover gives access to all working parts.

To remove ball bearings, place rotor with outer edge on block with hole ⅛ in. larger than o.d. of bearing. Insert thin piece of brass or aluminum in each rotor slot successively and tap lightly to force bearing off shaft. Strip metal should be at least an inch longer than blades.

Metering collar is anchored to rotor by a pin pressed lightly into hole in shaft. To remove pin, bump end of shaft lightly on wooden bench.

Sleeve can be removed by forcing out anchor pin and heating body to about 250 deg. F. in gas oven or oil bath. Part can then be bumped out on wooden bench.

Relief valve may be disassembled by removing seat assembly and lock nut. Parts may be removed with wrench (place valve body securely in bench vise).

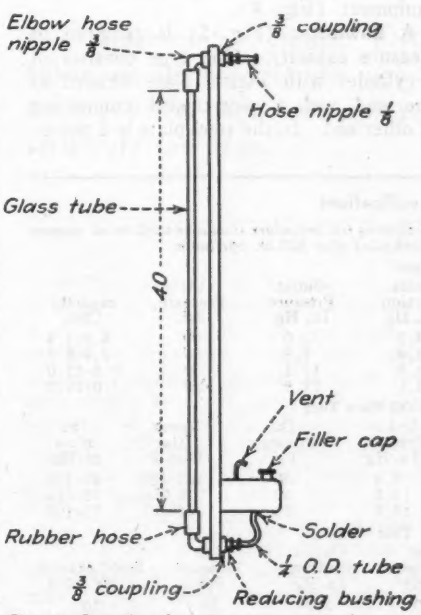


Fig. 6. Details of water manometer for use with flowmeter.

Disassembly of oil separator, other than screened outlet is neither advisable nor practical.

Safety valve may be completely disassembled by removing valve guide.

Check valves (both *3V-226* and *3V-311*) may be disassembled by removing cover screws.

After disassembling pump, wash all parts except front bearing in cleaning fluid. Don't wash front bearing, because fluid would dissolve grease with which it was packed by manufacturer. Inspect all parts carefully (Fig. 2) and replace any which are defective or which show signs of wear in excess of tolerances shown in Tables I and II.

If blades are rough or scored, dress on flat oilstone. Wearing edges may be dressed, but original curvature must be retained. Particles of aluminum from blades in smaller pumps may build up in rotor slots to cause excessive scuffing, in which case slots should be dressed carefully with flat, thin oilstone.

Replace bearings if rough turning. To test for roughness, hold outer race in one hand and turn inner race with fingers, pressing endwise. Test both sides this way. Check for radial roughness by turning inner race while pressing radially with finger. Repack front bearing with high temperature grease after every 1,000 hr. operation. To open bearing for inspection, lift out snap ring with knife blade and carefully remove seal disk.

Metering pin and collar should not be lapped or reamed but should be replaced if worn. Excessive oil consumption will result from changing dimensions of either by reaming or lapping.

Examine coupling for broken, cracked, or weak springs. If any parts show signs of wear or weakness, replace immediately.

Measure all parts to assure that allowable fits and clearances (as given in Tables I and II) are within limits. If these measurements cannot be maintained by replacements, renew the worn part.

Relief valve bakelite disk should be redressed on smooth flat oilstone, if necessary. Spring pressure should be not less than 16 oz. when spring is compressed to 1⅛ in.

Pump Reassembly

Heat body to about 250 deg. F. and insert sleeve so that anchor pin hole corresponds with hole in body. Insert pin and peen edge of hole to retain pin. Insert metering pin in cover carefully to prevent tilting, which would cause misalignment with collar.

When mounting cover assembly on pump, take care that pin does not wedge in collar. Rotate collar from side to side, as metering pin engages collar, until dowel pin in body enters locating hole in cover.

Test pump for freedom by turning by hand. If coupling will not turn, bump assembly in wooden bench to free parts. Also wash out pump with cleaning fluid to remove any particles of foreign matter. If necessary, disassemble pump to recheck clearances and eliminate tight spots. When pump turns freely after reassembly, proceed with—

Final Test

A satisfactory service test for pumps can be performed with any equipment which will give reasonably accurate indication of amount of air passing through pump and rate of consumption of lubricating oil. Factory test equipment is more extensive than required for routine service testing (Fig. 3). For this reason, only essential apparatus is described here, virtually all of which may be made in any hangar workshop or will be found already on hand. Equipment should be arranged according to diagram.

It is important that pump coupling have good alignment with mounting stand drive gear. Mounting unit consists of base fixture with drive shaft supported by ball bearings.

A 3- or 5-hp. electric motor coupled to mounting-stand drive gear through speed control is recommended for all vacuum pump testing. Three essential test speeds —1,500, 2,250 and 3,750 rpm.—must be provided, either by variable speed reducer or by simple pulley combinations. If speed

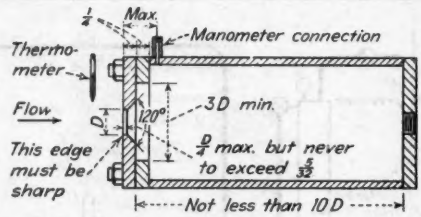


Fig. 5. Details of flowmeter for measuring airflow of small vacuum pumps.

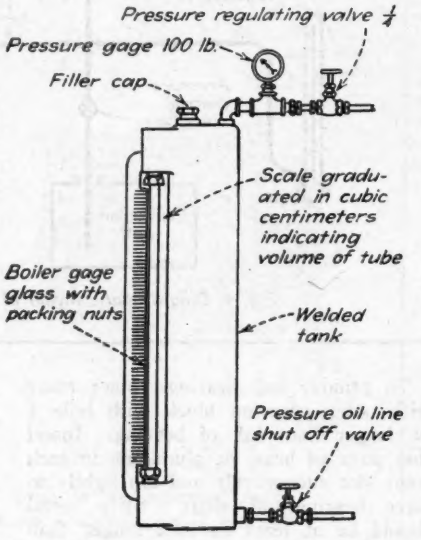

Pressure regulating valve
Pressure gage 100 lb.
Filler cap
Scale graduated in cubic centimeters indicating volume of tube
Boiler gage glass with packing nuts
Welded tank
Pressure oil line shut off valve

Fig. 7. Layout for oil consumption metering tank.

control is such that a wide selection of speeds is available, a means of indicating pump shaft speed is required, but if variation is limited to a few predetermined speeds, as with fixed pulley ratios or with certain types of electric controls, a tachometer is not necessary, though occasional checking with a hand tachometer is desirable.

Bench should be at least 35 in. high and large enough to accommodate all test equipment (Fig. 4).

A flowmeter (Fig. 5) is required to measure capacity. One type consists of a cylinder with a steel plate secured to one end and a pipe-tapped connection at other end. In the steel plate is a sharp-edged orifice through which air is drawn into cylinder to which suction port of vacuum pump is connected. Slight vacuum created in cylinder next to orifice varies with air flow and can be measured by a water manometer, with scale graduated to show capacity in cu.ft. per min (Fig. 6).

Intake suction and discharge pressure can be controlled by valves in intake and discharge lines and is indicated by mercury manometer connected close to pump ports.

Test set requires a means of supplying lubricating oil at pressures of 50-70 psi. in such a way that the quantity consumed in a given time can be measured. This can be accomplished by a supply tank (as shown in Fig. 7). Air pressure is introduced on top of the oil. Glass tube not only indicates quantity of oil in tank but also serves as a measuring device. When it is desired to measure pump oil consumption, valve at lower end of tube is closed, so that only oil in tube itself will flow into feed line. Scale mounted next to tube indicates volume in cc. With this device, pump oil consumption can be measured accurately over a given period.

A pair of mercury manometers will serve for measuring intake suction and discharge pressures, when connected close to pump ports. Suction and discharge pressure are controlled by valves in suction and discharge lines.

Two thermometers are required for measuring air temperature rise. One is mounted next to orifice in flowmeter and the other in the discharge line. The latter should have a range up to 350 deg. F.

Power absorbed may be measured by a dynamometer, or a wattmeter may be used to measure power in watts absorbed by motor both with and without load.

Tubing of ¾-in. dia. is large enough for test work. Care should be taken to avoid sharp kinks, and as few restricting fittings as possible should be used. The discharge line should terminate in a large expansion tank.

Test Procedure

Before mounting pump on the test stand, remove shipping plugs and check freedom of operation by hand. If pump tends to stick or bind, hold it by flange and tap end of coupling sharply with wooden mallet. This will free parts and prevent scoring. When pump operates freely by hand, mount it on test stand and connect the oil line to ⅛ in. P.T. connection on top of pump. During test runs, oil must be supplied to pump at 50-70 psi. Test procedures for all vacuum pumps are essentially the same; however, constant reference to test specifications in Table III is important. Recommended procedure is as follows:

Vacuum pumps must be run in after overhaul to make sure they are functioning properly. Prelubricate slightly with several shots of oil in intake port and run for 1 hr. at 3,500 rpm. with minimum suction and discharge pressure. During this period, grade 120 lubricating oil, must be supplied at not less than 50 psi. One of the tapped holes on top of pump may be used for this purpose.

(*Turn to page 267*)

Table III—Test Specifications

In accordance with latest Army and Navy specifications following test procedure should be used on all vacuum pumps. A 10 per cent deviation is acceptable on pumps overhauled after 500 hr. operation.

Capacity Test

Series	Rpm.	Inlet Suction In. Hg	Outlet Pressure In. Hg	Oil Pressure Psi.	capacity Cfm.
3-P194	1,500	4.2	2.0	50	4.5–4.9
3P-207	1,500	4.4	1.8	50	7.9–8.7
3P-207	2,250	4.5	17.1	50	9.8–11.0
3P-211	2,250	4.1	17.5	50	17.0–19.0

Temperature Rise and Oil Flow Test

Series	Rpm.	Inlet Suction In. Hg	Outlet Pressure In. Hg	Oil Pressure Psi.	Temp. Rise Deg. F.	Oil Flow cc/Hr.
3P-194	3,675–3,825	6.85	3.4	50	142–152	40–120
3P-207	3,675–3,825	6.4	18.5	50	275 Max.	75–215
3P-211	3,675–3,825	6.6	17.5	50	247–257	75–190

Seal Leakage Test

Series	Rpm.	Inlet Suction In. Hg	Outlet Pressure In. Hg	Oil Pressure Psi.	Seal Leakage cc/Hr. Max.
3P-194	3,750	8.0	3.35	50	10
3P-207	3,750	8.7	5.5	50	10
3P-211	3,750	7.2	19.3	50	10

Over-all view of colossal overhaul job tackled by Pan-American's airline maintenance department. Photo shows how PAA's Atlantic Division is making structural replacements to Boeing 314 "Clippers." Massive jigs attached to wing center section hold craft in flying position for removal and replacement of both vertical hull and hull bottom truss members. Note location of wing jigs close to airplane, which has been nosed into hangar corner to be out of way of routine servicing of other craft. (All photos by PAA.)

REBUILDING THE "CLIPPERS"

Pan American's Atlantic Division maintenance department has taken on its biggest job yet — replacing structural members of Boeing 314's. And through pre-engineering they're doing it in strikingly fast time.

WHAT IS UNDOUBTEDLY the most comprehensive overhaul job yet undertaken by an airline maintenance department is today in progress at Pan American Airways' Atlantic Division headquarters at LaGuardia Field, N. Y., where the first of eight Boeing 314 *Clippers* scheduled to "get the works" is literally being rebuilt.

This project is no mere refurbishing of eight large flying boats for it includes, as a precautionary measure, replacement of a minimum of eight wing spar-chord members, more than 20 wing web members, and 23 hull bulkhead members. Magnitude of the job is best shown by the fact that it was necessary to build jigs capable of supporting not only wings but also hulls of these 84,000-lb. gross weight craft.

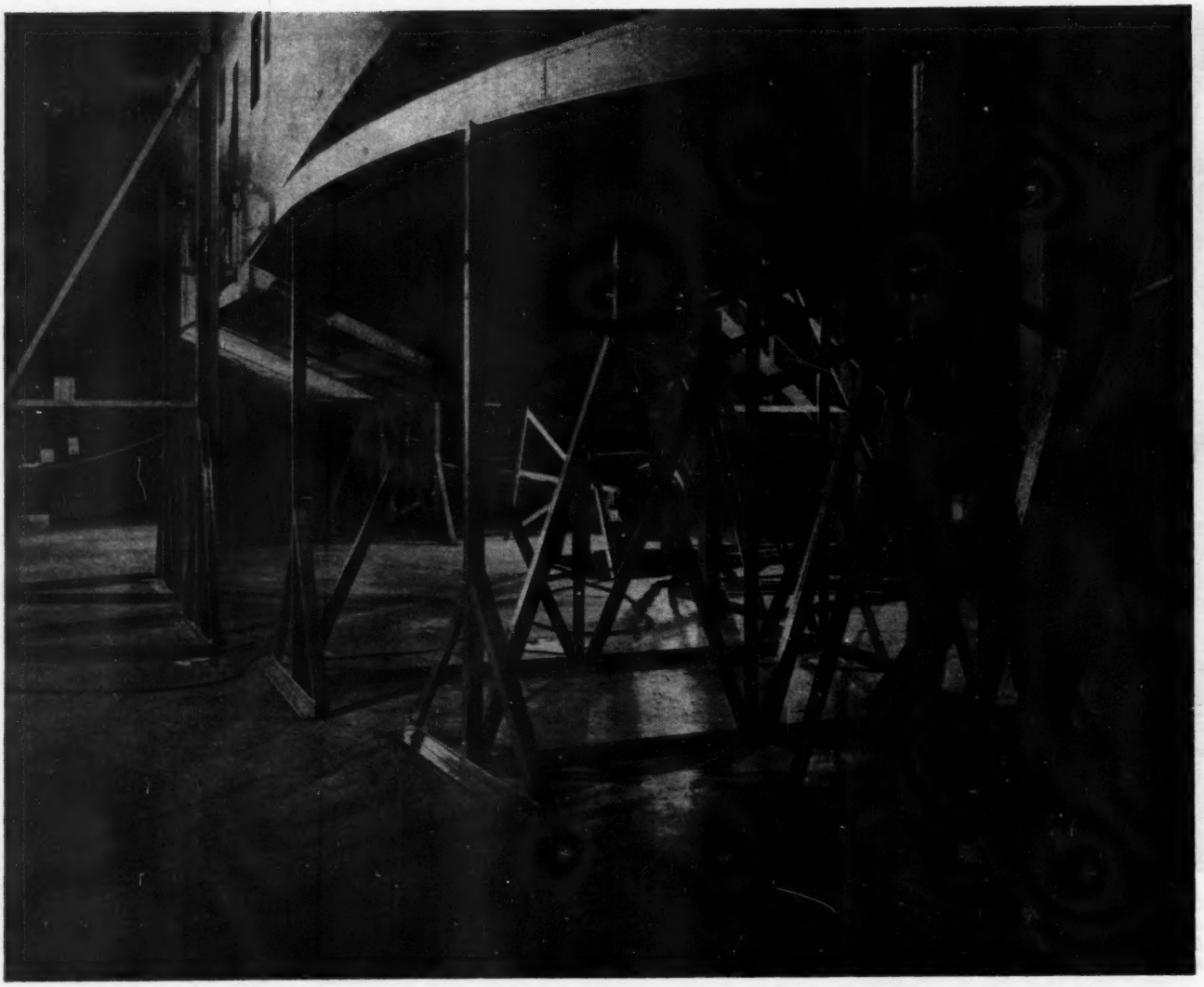
And, as the size of both the military and commercial planes increases, the project assumes more than mere interest; it becomes important as a handbook of experience.

First step in the completely pre-engineered process was to remove tail surfaces, propellers, engines, hydrostabilizers ("sea wings" peculiar to this type of craft), wingtips and, finally, outer wing panels. Inasmuch as the airplane had major parts removed, precautions had to be taken to keep the airplane in balance while it was moved on the beaching gear. This was accomplished by using sandbags in the bow.

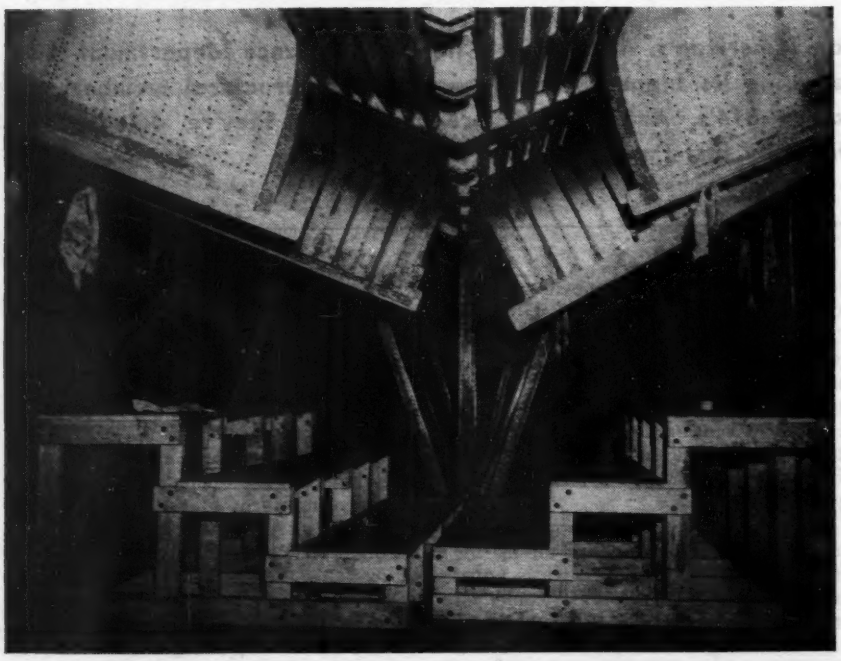
All components were removed under the chain hoist in the center of the marine terminal hangar, then the hull was nosed into a corner where the craft would not interfere with routine servicing of sister ships remaining in service.

Here the hull and its beaching gear were raised—20 in. at the aft end of the step to get it in flying position—then the hull was attached to jigs at the wing center section fittings. These jigs, 28 ft. high and weighing approximately 6,000 lb. each, were attached along the bottom by heavy steel tie-through members to assure alignment and eliminate the necessity of anchoring them to the hangar floor. Additional alignment checks are provided by jigs attached to the hydrostabilizer fittings.

With the hull attached to the jigs, the beaching gear was withdrawn from the aft end of the airplane and six hull bot-



Close-up of hull bottom cradles, used both to distribute weight over hangar floor and to help maintain hull position during removal and replacement of structural members. Jig at left attaches to hydrostabilizer (or "sea wing") fittings and serves to maintain alignment during project. All jigs, of welded steel construction, were built by PAA's Atlantic Division maintenance department. Wood and canvas padding is used between cradles and hull bottom to protect the hull from damage by motion during repair.



tom cradles were installed, three forward and three aft of the hydrostabilizer jigs. These hull-bottom cradles are constructed of welded steel angle members with wood and canvas padding cut to fit the hull curves. They serve both to distribute the weight of the hull bottom and also to hold it in position while main structural members are being replaced.

Interior of the airplane was completely stripped, with the multitude of parts going to storage, salvage, or specialized repair

Three-level work stands built by maintenance department to facilitate underhull work. This view, looking aft along "Clipper" hull, shows how bottom skin has been peeled back to give access to truss members slated for replacement. Great care has been taken in removal of rivets and bolts so that same sizes can be used when new structural members are in place and skin is again attached. All structural members removed are handled with extreme care, since they serve as templates for new members going into planes.

departments, and then replacement of hull structural members began.

These include the vertical square tubular members running from the wing center section spars down through the hydrostabilizer attaching points to the truss structure forming the bottom of the hull, also the majority of the tubular members in the corresponding bilge trusses.

To do this, it was first necessary to disconnect the deck (or cabin flooring) from the main lounge, as well as the next two compartments, so that both front and rear spar bulkhead lower truss structures could be removed as units. This, in turn, required removal of chine and keel sections to permit loosening of the hull bottom skin to give access to the truss sections. Similarly, skin along the sides of the hull near the vertical members was loosened and peeled back to give access to them.

In each case, skin was loosened by very careful drilling of rivet heads, then popping out the rivet. Thus, replacement of the skin can be made with the same size rivets used in original construction of the *Clippers.*

Removal of the vertical hull members would appear to be a simple cutting-away job; but such was not the case, for the members themselves have been used as templates for replacement members. Thus it has been necessary to remove bolts and rivets with extreme care to avoid making the holes in the gusset plates and other attaching members any larger than allowable limits called for in the original design.

Members being replaced in both wings are the front and rear spar upper and lower chord members from the wing attachment terminal through the first splice, or from the outer wing panel attaching point outboard through seven ribs, a matter of 174 in., and web members in the area. Replacement order is as follows: Rear spar lower, front spar lower, rear spar upper, and front spar upper.

After the hull had been nosed into the hangar corner, the outer wing panels were placed in their jigs at right angles to each other and close enough to the hull to permit uninterrupted normal maintenance on other craft.

As in the case of the hull jigs, wings—also constructed by the Atlantic Division's maintenance department—were made of welded steel angle and I-beam members with machined fittings. One of these jigs supports the wing at the wingtip fittings, the other at the outer panel-to-center section fittings. In addition, there is a flap jig, consisting of four pyramidal stands supporting a heavy steel bar attached to the flap fittings and serving as an alignment jig to insure accuracy during removal and replacement of the rear spar chord members. Load distribution is effected by a wooden framework placed under each spar extending from the wingtip jig inboard to the splice where chord members were being replaced.

With the wings in jigs, fabric covering (which extends from the rear spar to the trailing edge) was removed. In order to gain access to the rear spar chord clip-attaching bolts, the lower chord

Looking through hydrostabilizer jigs. Hull bottom skin has been loosened and peeled back only far enough to give adequate working room for removal of structural members being replaced. Vertical jig member at left attaches to both top and bottom hydrostabilizer leading edge fittings; that at right to top and bottom trailing edge fittings. This is first of eight "Clippers" scheduled for program.

members of seven trailing edge ribs were cut approximately 12 in. aft of the spar. This 12-in. section was removed by drilling out rivets through chord and spar clip and also the rivets attaching the trapezoidal rib chord gusset plates to the rear spar cap.

In all wing work, as in the hull, removal of rivets and bolts required extreme care to keep holes from being enlarged. And here, too, removal of the members themselves required extreme care, both to utilize the members as templates for replacement structures and to prevent scratching of gussets and webs remaining in place.

Four types of alignment checks are

(*Turn to page* 269)

Inboard wing jig, with wing in place and leading-edge skin peeled back to permit removal of spar-chord member. Beyond outboard engine nacelle a long wooden cradle has been place beneath spar to distribute weight and maintain alignment. Similar jig is used at outboard end, attaching to wingtop attachment fittings. In addition, four pyramidal stands form basic structure of flap alignment jig.

MAINTENANCE

Inspection and Top Overhaul On the Franklin

By **F. B. CHADWICK,** *Service Manager, Aircooled Motors Corp.*

Power plant check-up and service—by a precise routine—comprises the small plane owner's "performance insurance." Here are the 10, 25, and 100-hr. steps, plus top overhaul details.

LIKE ITS LARGE high-power brother on fighters, bombers, and airlines, the modern light aircraft engine is the product of years of experience and superlative engineering talent. But, also like the big fellows, it must be carefully inspected and serviced if it is to give the satisfaction which the designer claims and the owner has a right to expect.

Inspection is divided into three period categories: 10, 25, and 100-hr. The first is merely a checkup requiring a few minutes, for there is nothing which can normally require much attention after only 10 hr. flying. The 25 and 100-hr. inspections and top overhaul comprise the maintenance necessary to keep the engine operating successfully until the regular 500-hr. (or more) overhaul period.

Ten-Hour inspection calls for the following routine: Remove and clean fuel strainer. When replacing glass bowl, do not tighten until fuel has been allowed to run for a short time so that air will be driven from pipe line and strainer. The air will leak out round loose bowl, which is tightened after gasoline leaks out.

Wipe off sparkplugs and ignition cables to prevent danger of short circuits from oil or soot. Inspect all cable terminals on ignition system, both at sparkplugs and magneto.

Twenty-Five-Hour inspection: It is considered good practice to drain crankcase of oil at this time, refilling with SAE 20. Used oil should be passed through 20 mesh (or finer) strainer, which is then examined for metal particles that would serve as a danger signal regarding condition of engine.

Controls should be checked for operation through their full range, then lubricated.

Check and clean sparkplugs. Champion J-10 plugs should be used, with the gap set at .020 in. When tightening plugs use torque wrench with force of not more than 20 ft.-lb. Use a good mica base lubricant on sparkplug threads before installing, for this will obviate chances of stripping threads in cylinder head through overtightening.

If any of the high tension cable terminals are corroded or if the cable shows signs of being cracked, the defective length should be replaced. This is important because breaks in the insulation may cause sparks resulting in gasoline fires during operation. During this inspection, magneto points should be checked for pitting and tightness. Slight pitting is not harmful, but roughened surfaces call for refinishing of the points.

One-Hundred-Hour inspection is made after completing every fourth 25-hr. inspection. Valve covers are removed and valve guides checked for wear by pressing sidewise on spring with a screw driver. Excess clearance indicates that the valves are not only seating incorrectly but that the lubricating oil is probably being blown out by the pressure of the exhaust gas. In addition, air is often admitted on the intake stroke, resulting in too lean a mixture, which causes head overheating and warped valves. Minimum clearance should be .0025 in., maximum .0043. Carburetor should be cleaned by an experienced mechanic, jets being *blown out with air*—not cleaned with a wire, which usually results in an enlarged jet, cause of bad metering.

Clean out all fuel lines and strainers, including that in shut-off at tank. Wash out tank with clean gasoline and make sure all sediment is removed.

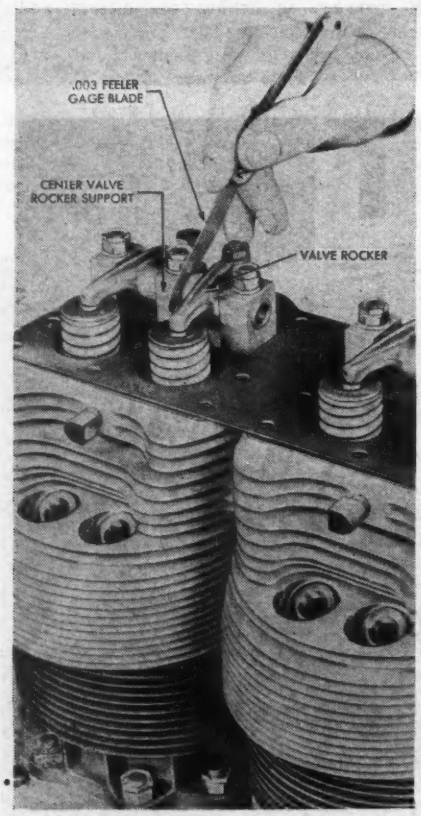


Fig. 1. Franklin cylinder head and valve rockers. Here, feeler gage is used to check side clearance between rocker and bracket.

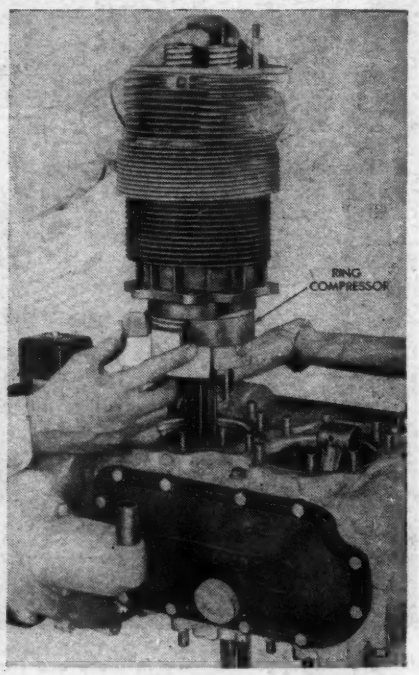


Fig. 2. When replacing cylinder, ring compressor of thin sheet metal is employed to prevent rings from catching or breaking.

Top Overhaul

This work is not always required between major overhaul periods, but experience has proved that increased efficiency and operating economy are often realized because of top overhaul at about 250 flying hours.

Before "revving up" engine at full throttle on ground to determine need of top overhaul, perform following inspection and adjustment: Check spark timing, seeing that spark occurs in position given on engine nameplate. Check over items in 10, 25, and 100-hr. inspections. Check throttle lever to make sure throttle opens fully when lever is against forward stop.

While engine is cool check compression by swinging prop with throttle wide open and listening through exhaust ports

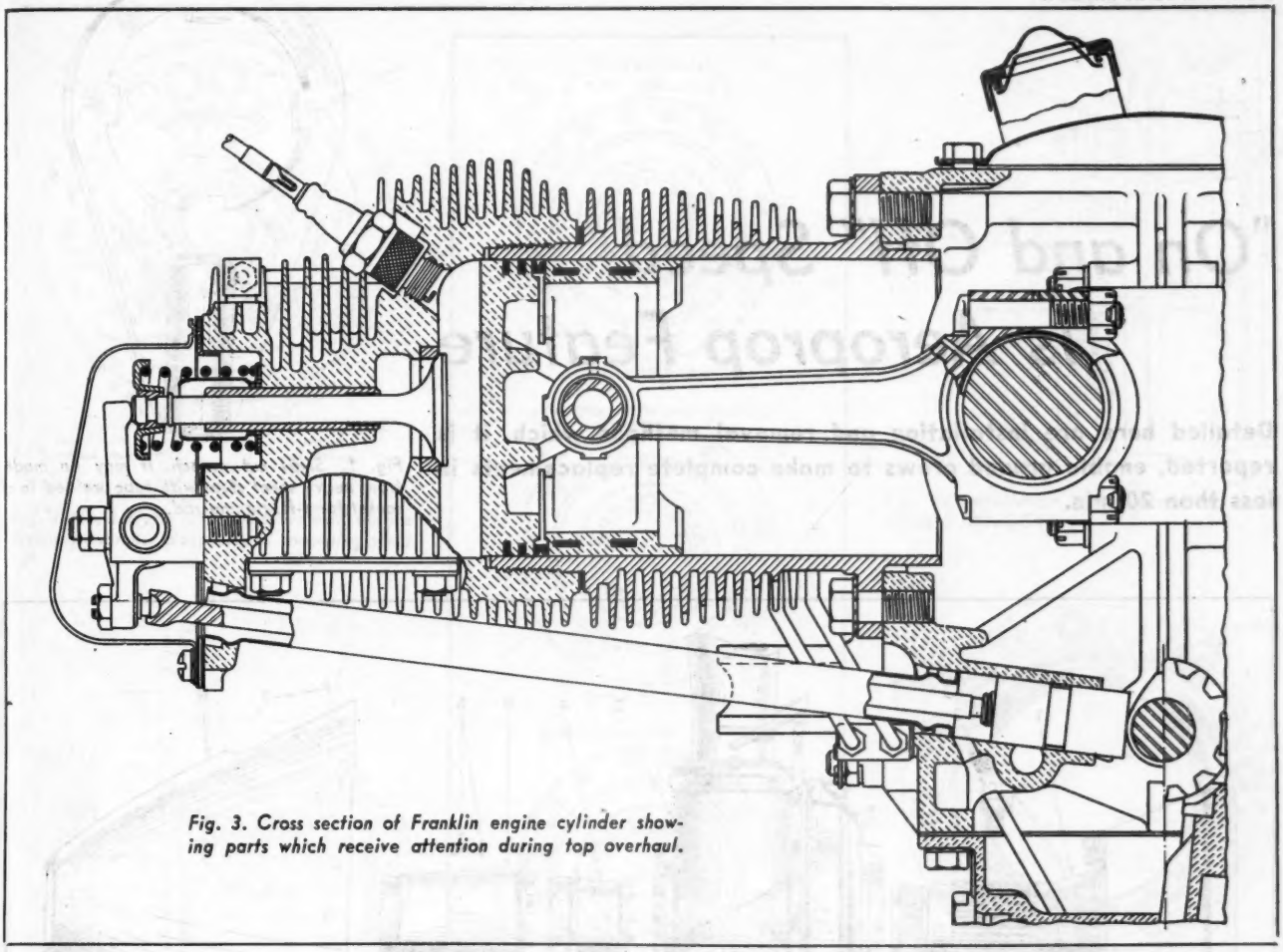


Fig. 3. Cross section of Franklin engine cylinder showing parts which receive attention during top overhaul.

and carburetor for blowing valves.

Warm up engine until oil is about 100 deg. F., then open throttle and note maximum rpm. with standard prop. If minimum rpm. is not reached, top overhaul is probably necessary.

Top overhaul is accomplished without removing engine from plane. Select a spot free from dust and remove engine cowling and air housings. Take out sparkplugs and remove cylinders. If gasket sticks, tap cylinders lightly with wooden hammer. Raise cylinders slightly in removing them, being careful that pistons do not fall against crankcase. It is considered good practice to slip pieces of split hose, of about 1½-in. dia., over connecting rods to prevent damage to aluminum crankcase. Remove propeller or tie it tightly to prevent movement, otherwise it may be turned with resulting damage to engine.

With valves in place, scrape carbon from inside head. Then remove valves by placing wood block, 7 in. long, inside cylinder, with cylinder resting on bench. Remove valve cap and press down on springs until split cone is removable. When removing valve springs, etc., tag them so they will be returned to their original location. A steel bar, ¼ x 1¾ and about 14 in. long with ¾ in. hole in center, makes a good valve removing tool.

Clean all parts with gasoline and inspect valves and seats for cracks, burning, and wear. Do not re-face valves and seats unless absolutely essential since this operation usually results in more metal being removed than is necessary. If new valve seats are required, cylinder should be returned to factory, where new seats are shrunk in place by machinery.

If valves are pitted, burned, or grained, intake valve should be re-faced to 30-deg. angle and exhaust to 45 deg. Carbon should be removed from valves very carefully to preserve original surface unscratched. Emery cloth not coarser than No. 150 may be used on valve stems (coarser cloth has a tendency to remove gloss and surface hardening). After lapping valves, test by pouring gasoline in ports or by using air pressure in cylinders.

Valve springs should be thoroughly cleaned and inspected for cracks. A pressure of 44-50 lb. should be supported by valve stem when spring is installed. If spring does not support 44 lb., remove spring and place washers beneath it until required pressure is obtained. If more than two $\frac{1}{16}$ in. washers are required, springs are too weak and should be replaced. When valve is fully open, spaces in spring should be not less than .010 in. Rusty springs should always be discarded immediately as they are likely to break without warning.

Cylinders should be checked for wear and taper with an inside micromter. Cylinders worn more than .002 or .003 should be exchanged for new ones, this method enabling original piston to be used. Measurements should be taken upward to a distance of approximately 5 in. from the lowest edge of the cylinder skirt. Above that point an inward taper will probably be noted—which is normal.

In assembling valve mechanisms, make sure chamfer on narrow end of rocker pin is toward center of cylinder, otherwise it will foul valve spring. Oil hole in rocker pin bearing should be towards cylinder center.

Barrel end of rocker arm should line up accurately with valve stem center. This line-up may be accomplished by slightly loosening the nuts on support studs, tapping rocker arm until it is in line, then tightening nuts again. Palnuts should be used for safetying.

Valve rocker caps should be left off until cylinders are bolted down on crankcase—because it will not be possible before that time to check the alignment of the lifter rods at the ball end of the valve adjusting screws.

Assembling of cylinders to crankcase (always using new gaskets) should only be done after both cylinders and crankcase have been thoroughly inspected and cleaned. Cylinder walls and also piston rings should be heavily coated with cylinder oil. A band type of ring clamp should be employed when sliding cylinder over

(*Turn to page 270*)

"On and Off" Speed Is Aeroprop Feature

Detailed here are installation and removal methods which, it is reported, enable ground crews to make complete replacements in less than 20 min.

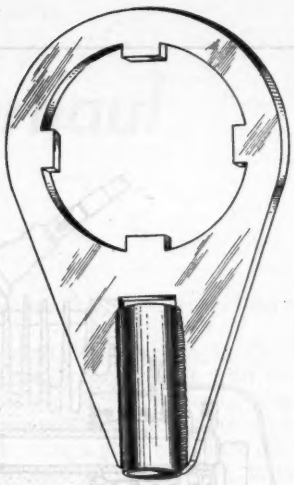


Fig. 1. Shaft nut wrench. It may be made from heavy sheet steel with tube welded in a socket for 4-ft. turning rod.

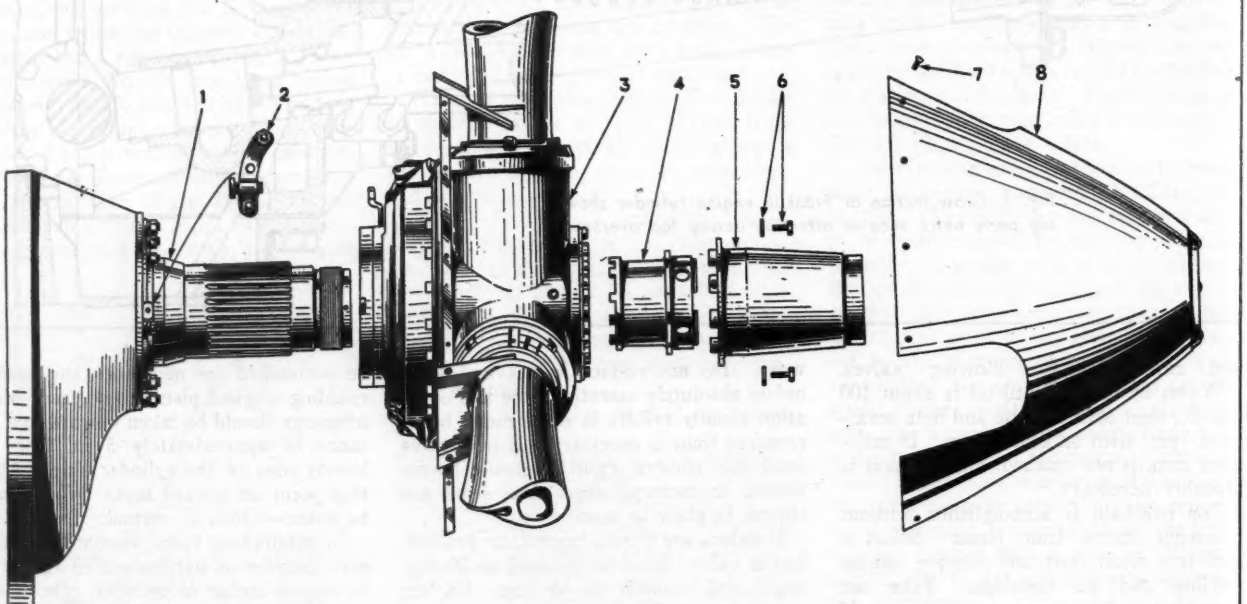


Fig. 2. Aeroprop installation: (1) Is rear cone; (2) stop assembly; (3) propeller; (4) shaft nut locking screw; (5) spinner adapter; (6) adapter screws and washers (9 required); (7) spinner patent attaching screws; and (8) spinner shell.

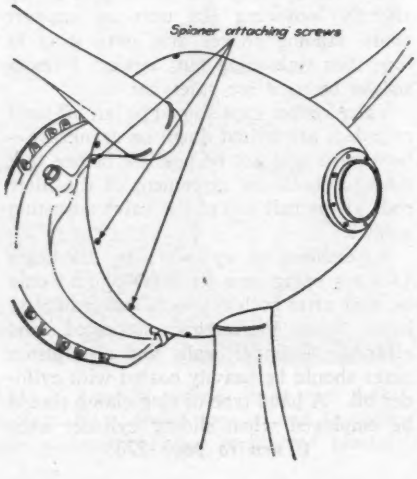


Fig. 3. Removal of spinner shell. Spacing of dowels prevents replacement in wrong position, but care should be taken to check serial numbers on shell and bulkhead, which should be the same.

FOR INSTALLATION AND REMOVAL of Aeroprop propellers but one special tool is required—that shown here in Fig. 7. This tool may be fabricated or purchased from the manufacturer. Used in Conjunction with the propeller shaft nut locking sleeve (seen at 4 in Fig. 2) this wrench is for tightening or loosening propeller shaft nut.

As may be seen by reference to Fig. 2, the propeller is centered at rear by rear cone 1 and is secured in front by shaft nut locking sleeve 4, which must be removed before the propeller can be slid forwards off shaft.

Spinner-adapter 5 centers spinner shell 8 and is attached to front of propeller by safety cap screws.

Non-rotating parts are held stationary by stop 2, which is variously attached to front of engine reduction gear housing, as shown in Fig. 6b.

Removal Directions

On planes with tricycle landing gear, hang about 300 lb. on front wheel strut, or thereabouts, to compensate for propeller weight removed. Now remove spinner attaching screws (Fig. 3.) and

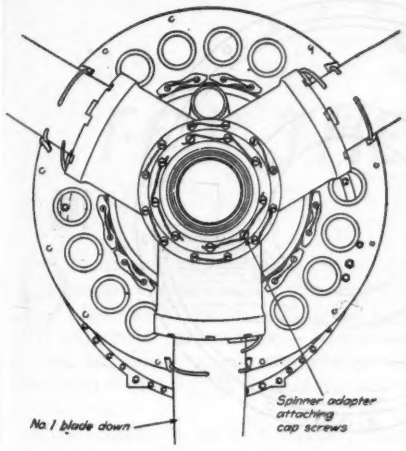


Fig. 4. No. 1 blade is turned downward before removing spinner adapter and loosening shaft nut.

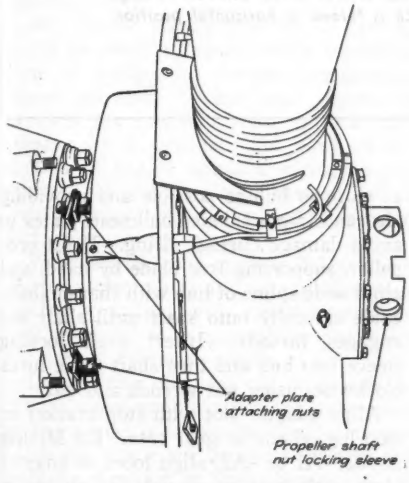


Fig. 5. On Models A632S-A1 and -A2, adapter plate attaching nuts are removed before loosening propeller shaft nut.

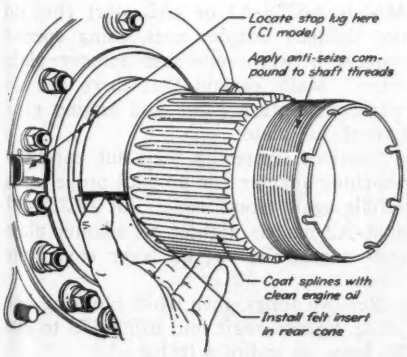

Locate stop lug here (C1 model)
Apply anti-seize compound to shaft threads
Coat splines with clean engine oil
Install felt insert in rear cone

Fig. 6. Steps taken when installing Aeroprop.

loosen and detach spinner, using palm of hand only in striking shell. *Do not use any* ***hard object on spinner at any time.*** Marking of the spinner to assure replacement in same position is not necessary, for offset dowels allow it to be remounted only in original position.

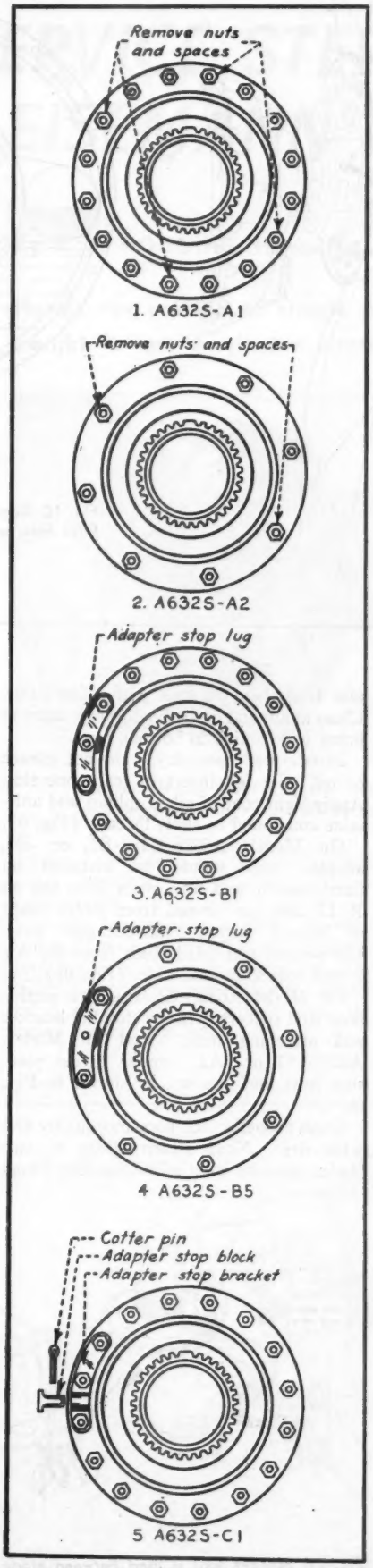


Fig. 6b. Methods of mounting adapter stop for various models.

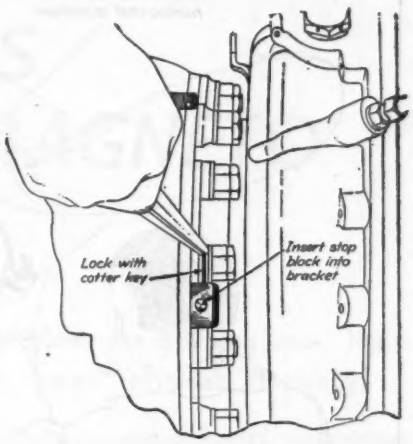


Fig. 7. Installation of adapter stop block (Model A632S-C1).

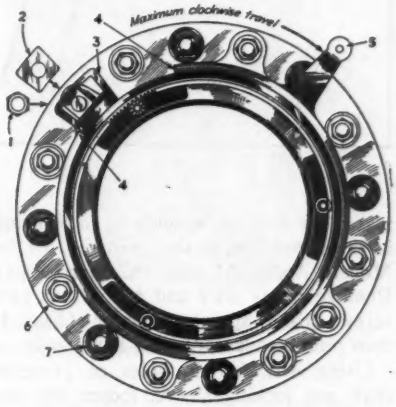


Fig. 8. Adjustments of lever stop plate, Models A632S-A1 and A2: (1) Is nut; (2) stop plate washer; (3) lever stop plate; (4) control lever stops; (5) control lever; (6) studs (those shown unshaded are removed on 8-stud reduction gear case); (7) studs (those shown shaded remain on 8-stud reduction gear case).

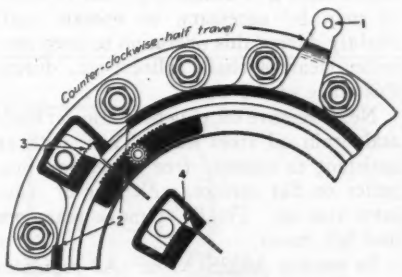


Fig. 9. Method of counting teeth on lever stop plate when making adjustments. (1) Is control lever and (2) control lever stops. Control teeth, as shown at (3), are counted, then set back three teeth from end, as at (4).

Turn propeller with oil plug downwards (Fig. 4), bringing wide spline on shaft downwards. Remove cowling inspection doors directly behind spinner. Then take out cotter key and clevis pin from regulator control lever (5 in Fig. 8).

If regulator adapter plate is bolted in

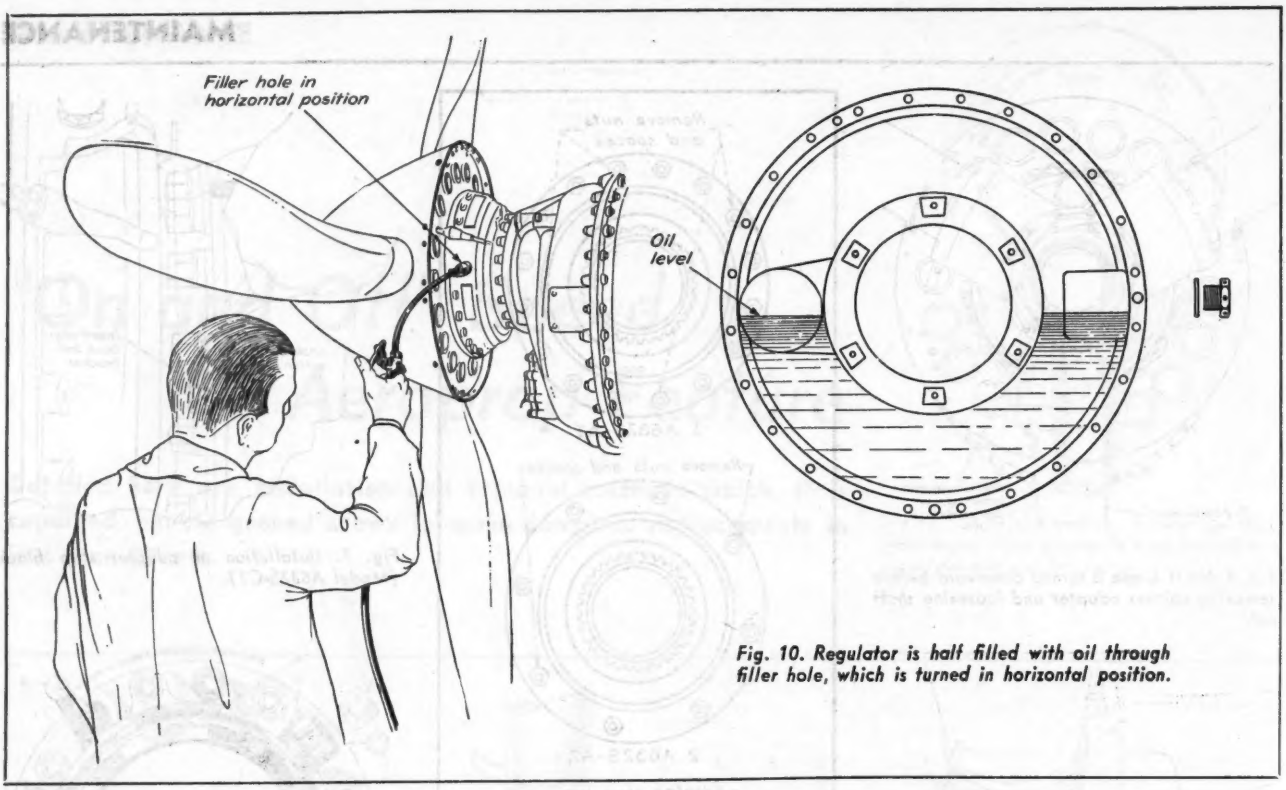


Fig. 10. Regulator is half filled with oil through filler hole, which is turned in horizontal position.

place, use a 5/8-in. wrench to loosen nuts as far as possible, as shown in Fig. 5 (For Models A632S-A1 and -A2 Aeroprops). Remove safety wire and ¾ – 28 hex capscrews from spinner adpater (Fig. 4) then remove adapter, using hands only.

Using 4-ft. bar in holes of propeller shaft nut locking sleeve, loosen nut two turns. If cannon is installed, use shaft nut wrench shown in Fig. 1 with same bar. Attach slings to two upper blades, as close as possible to hub. Take light strain on hoist, sufficient to take propeller shaft nut until it is clear of threads. Then, using great care to prevent bruising either of shaft or propeller, slide propeller forwards until it is completely clear of shaft. It may be necessary to operate hoist slightly during this operation to keep propeller clear of shaft, splines, etc., during this stage of the work.

Next, remove oil plug behind lower blade and drain oil from hub. Then, with an assistant to support free blade, lay propeller on flat surface, with rear or regulator side up. Finally, remove rear cone and felt insert.

In models A632S-A1 or -A2 regulator propellers, adapter plate and nuts must be removed as propeller nut is backed off. After each turn of propeller shaft nut, check adapter plate nuts until plate is clear of engine reduction-gear case studs.

Since spinner and bulkhead are balanced as a unit, they should be kept in pairs, together with the screws used to attach them.

Installation

Clean splines and rear cone seat thoroughly, using an approved cleaning fluid. Check entire surface for burrs or nicks and dress them off level with a fine stone. Clean again and dry. Then rotate shaft to bring wide spline to bottom.

Install rear cone dry. Do not grease or oil. Set felt insert in rear cone slot. Apply light coat of oil to splines and anti-seize compound to shaft threads (Fig. 6).

On Models A632S-C1, -B1, or -B5, adapter stop should be installed on third, fourth, and fifth studs from top on R. H. side (as viewed from pilot's seat) of 16-stud engine reduction-gear case. Use second and third studs from top for 8-stud reduction gear case. (Fig. 6b).

On Model A632S-C1, use two engine nose stud spacers between stop lug bracket and attaching nuts. And on Models A632S-A1 or -A2, remove thrust plate stud nuts and spacers, as shown in Fig. 6b.

Clean propeller hub bore thoroughly and wipe dry. Next attach slings to two blades opposite wide spline, keeping slings as close to hub as possible and providing clearance from spinner bulkhead plates to avoid damage during raising. Hoist propeller, supporting free blade by hand, and align wide spline of hub with that of shaft. Slide carefully onto shaft until shaft nut engages threads. Insert shaft locking sleeve into hub and turn shaft three turns clockwise, using nut wrench and bar.

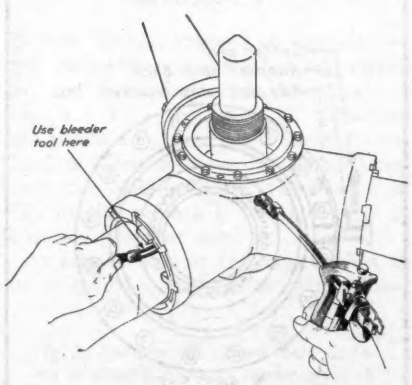


Fig. 11. Bleeder tool is used between blade and nut to permit escape of air as grease is forced into hub.

Align adapter slot with stop bracket or stop lug on engine gear case. On Models A-632S-A1 or -A2, align lobes of adapter plate with gear case studs, as shown in Fig. 8, and place lever stop plate on correct adapter plate lobe. Turn shaft nut locking sleeve two more turns clockwise while checking the above alignment. On Models A632S-A1 or -A2, start (but do not tighten) adapter nuts, using special spacers between nuts and adapter plate lobes. Make certain that there are no washers between lobes and engine gear case thrust plate.

Continue tightening shaft nut, carefully watching adapter line-up until propeller is solidly against rear cone. For A632S-A1 and -A2 models, tighten all adapter plate nuts except the one on lever stop plate lobe.

Remove slings, then while blocking one blade, tighten shaft nut, using 175 to 200 lb. force on end of 4 ft. bar.

Install spinner adapter secure with 1-28 capscrews and washers, and safety with .032 wire. If screw holes do not line up, remove adapter and rotate it one notch at a time until alignment is obtained. If necessary, tighten shaft nut slightly and repeat procedure.

Install stop block in bracket on A632S-C1 models and safety with cotter key (Fig. 7).

(*Turn to page 270*)

SERVICE STEPS FOR THE EISEMANN MAGNETO

By E. J. GOGGINS, *Eisemann Magneto Corp.*

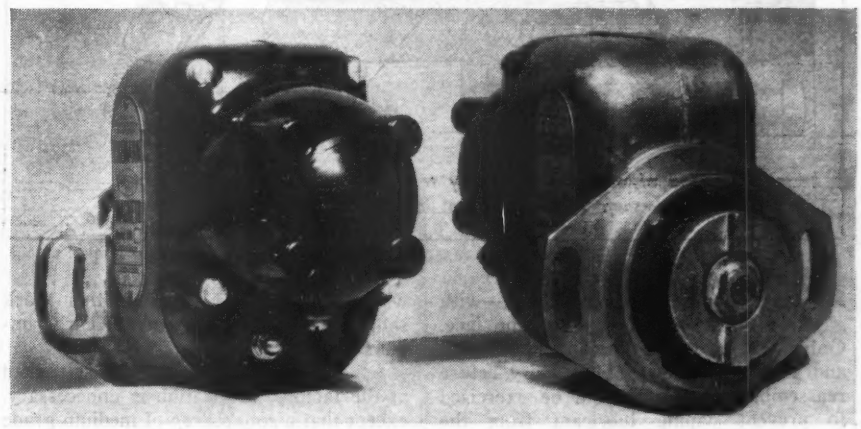
Here's the routine of simple operations for keeping new, lightweight 4- and 6-cylinder aircraft "mags" at peak efficiency.

DESIGN OF SMALL, lightweight aircraft engines calls for a magneto in which weight and bulk have been reduced to a minimum. It was for service on this type of engine that the Eisemann 4- and 6-cylinder magnetos were originated.

These magnetos are of the rotary-magnet, jump-spark distributor type, with aluminum-nickel-cobalt magnet and ventilated distributor housing. To reduce headroom, the secondary leads are taken from the end of the housing, rather than the top.

An impulse starter provides an intense spark at cranking speed, while retarding time of ignition to prevent pre-ignition when starting. When the engine is cranked the magneto rotor is held stationary by a catchpin and pawl, while motion of engine winds a spring in the starter. When the piston passes TDC a pawl releases the spring, which spins rotor and generates the spark.

When engine rpm. exceeds 200, impulse starter action ceases and the unit acts as a flexible coupling, with spark automatically advanced to exact position necessary for normal operating speed.



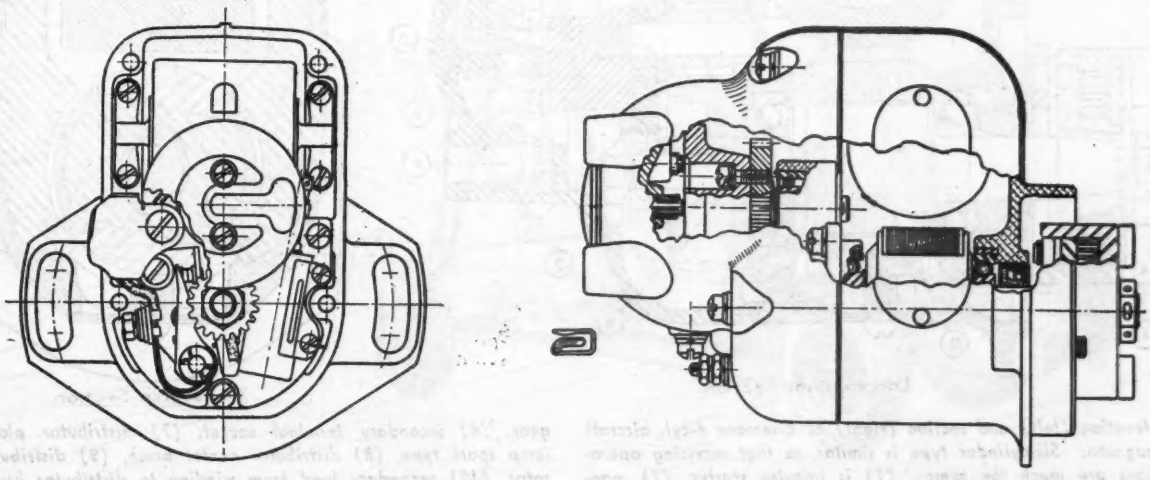
Eisemann Model AM-4 Magneto. Right: Impulse starter and mounting flange with adjusting slots. Left: Distributor housing and secondary lead terminals.

In servicing the unit the first step to set the magneto in position for connection to the engine is to remove the distributor plate and rotate the magneto shaft in the opposite direction to that when driven, in order not to engage the impulse starter. This rotation is continued until the rotor plate on the distributor points toward the lower left-hand cable position (approximately 7 o'clock), and as the contact points commence to separate, ignition spark occurs.

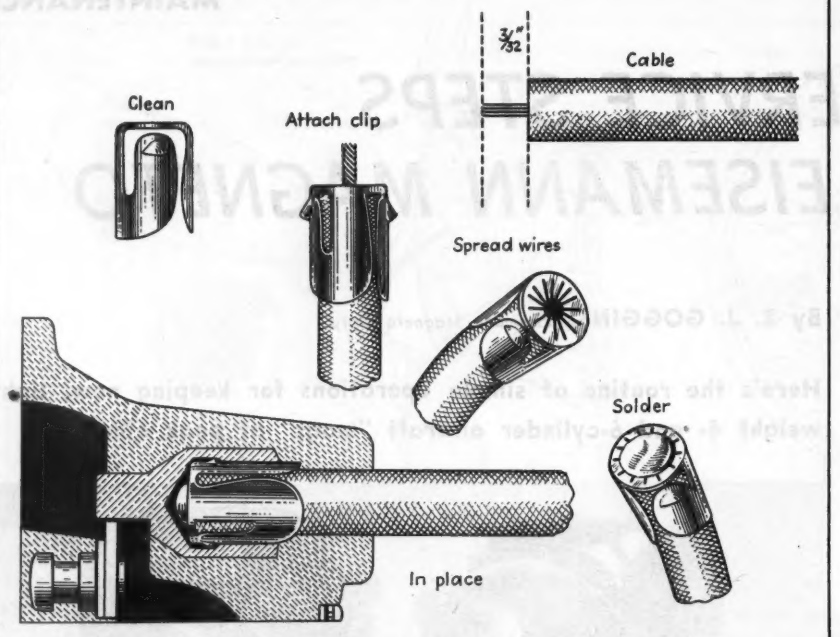
In this position the magneto is ready for installation on the engine, which should have No. 1 cylinder in firing position. The exact point at which ignition should occur should be ascertained from the engine maker's handbook.

Cables must be attached to the magneto by means of clips, as shown in the accompanying illustration. Only such clips should be used, since a projection is provided at the bottom of the cable holding recess to accommodate the projection at the clip end, and 7 mm. cable should be used.

The distributor should be cleaned with a



Interior views of 4-cyl. model. At left are winding (top), distributor rotor (center), breaker and condenser (bottom). Right-hand view shows distributor housing with secondary lead spring contact (top) and distributor terminals (left).



Method of attaching secondary terminal clips, which have integral catch to snap in place when inserted in terminal on magneto.

Shielded Model LA, 6-cyl. Eisemann magneto.

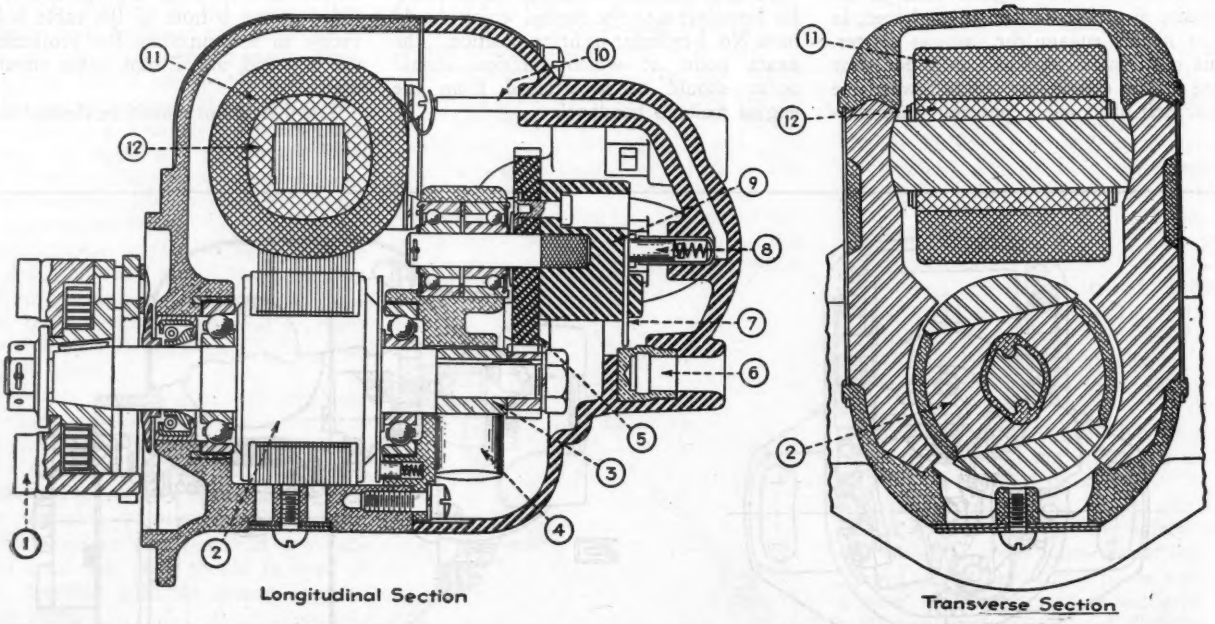
soft cloth, dampened—but not wet—with gasoline if carbon is found on the face. Only high grade gasoline should be used, and all parts should be wiped dry before reassembling. Care should be exercised to prevent wiping lubricant from the breaker cam face. Abrasives should never be used on the breaker cam distributor plate or distributor rotor.

Contact points should not be filed, but when they require dressing this work should be done with a smooth carborundum stone.

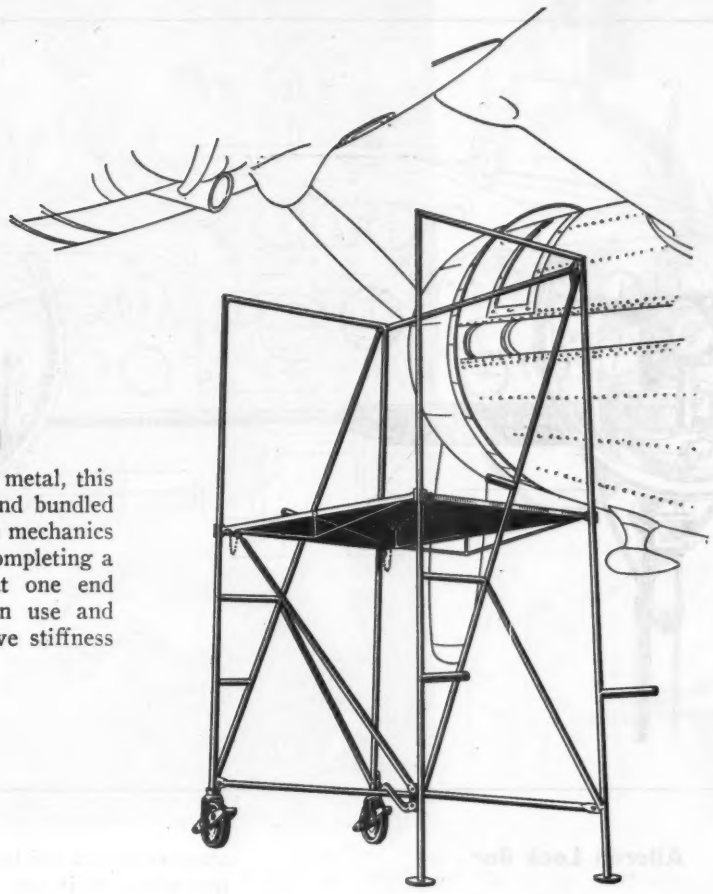
As all ball bearings are grease-packed at the factory, lubrication is unnecessary, except that a *single drop* of medium grade engine oil may be applied to the breaker cam wick after every 500 hr.

Impulse starter pawls should be loosened with a small amount of kerosene at inspection; a small can should be used to prevent flooding. Contact points should separate from .019-.021 in. In checking the gap, the shaft should be turned until the breaker fiber rests atop the cam, at which point the gap between points should be measured with a feeler gage. To avoid action of the impulse starter, the shaft should be turned backward during this operation.

As the entire breaker assembly turns on the breaker lever bearing pin, the gap may be adjusted without altering the relationship between surfaces of the breaker lever contact and fixed contact. If, however, it is necessary to adjust the gap, this can be done by loosening the breaker plate fastening screw and moving the entire breaker assembly toward the cam to increase gap, or away to decrease it. The gap opening should be re-checked after the breaker fastening screw has been tightened.

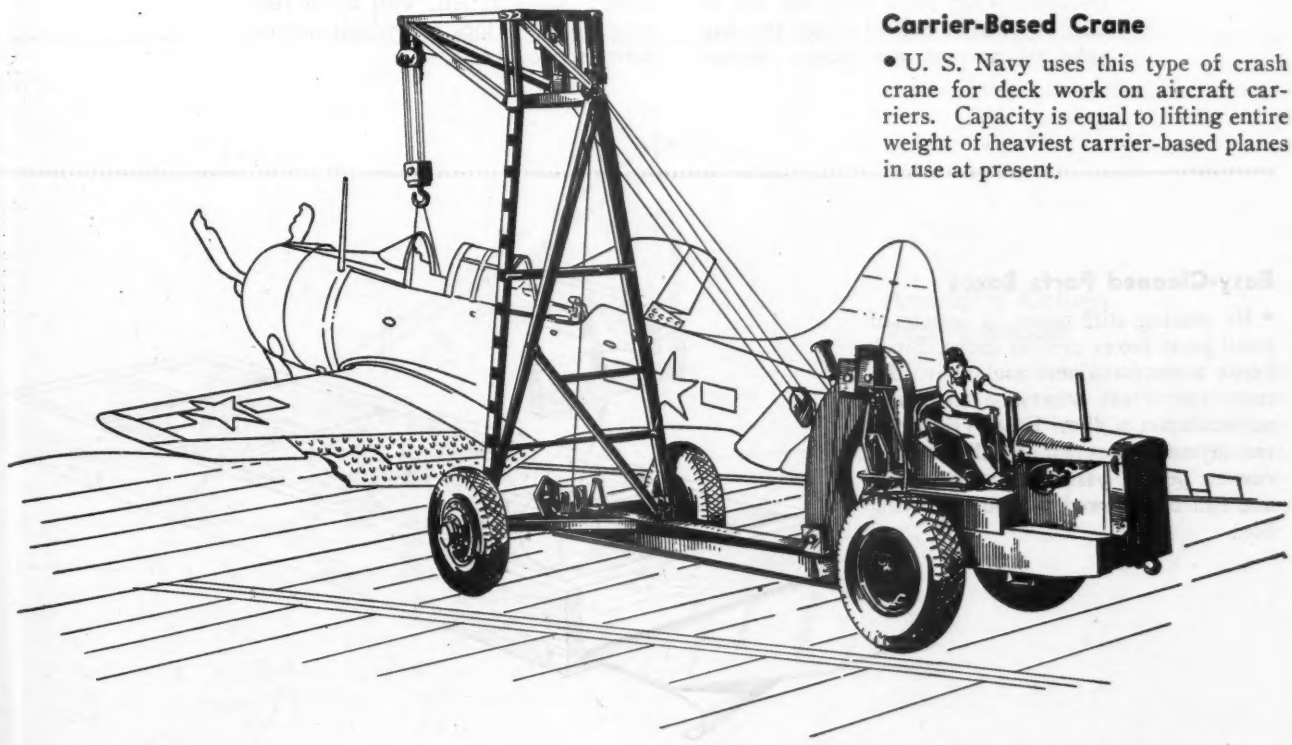


Elevation (left) and section (right) of Eisemann 4-cyl. aircraft magneto. Six-cylinder type is similar, so that servicing operations are much the same. (1) is impulse starter, (2) magnet rotor, (3) breaker cam, (4) condenser, (5) distributor gear, (6) secondary terminal socket, (7) distributor plate, jump spark type, (8) distributor center brush, (9) distributor rotor, (10) secondary lead from winding to distributor brush, (11) secondary winding, and (12) primary winding.



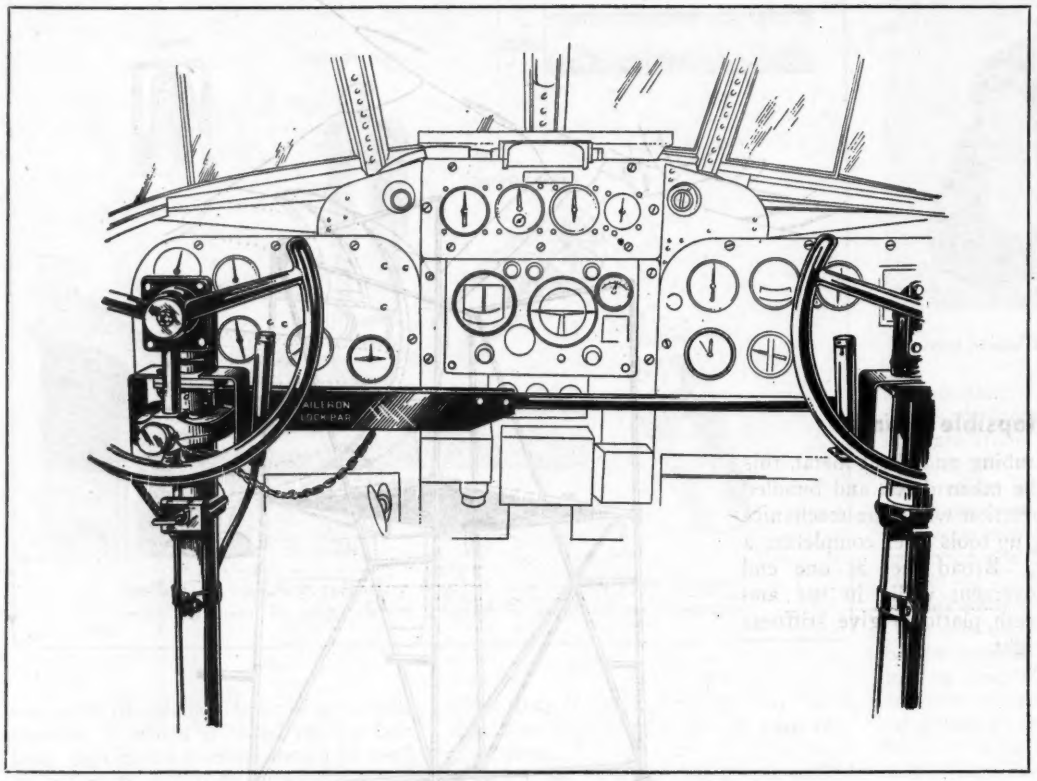
AAF Collapsible Stand

• Built of tubing and sheet metal, this stand can be taken down and bundled for transportation while the mechanics are picking up tools after completing a repair job. Broad feet at one end prevent movement while in use and braces beneath platform give stiffness without weight.



Carrier-Based Crane

• U. S. Navy uses this type of crash crane for deck work on aircraft carriers. Capacity is equal to lifting entire weight of heaviest carrier-based planes in use at present.

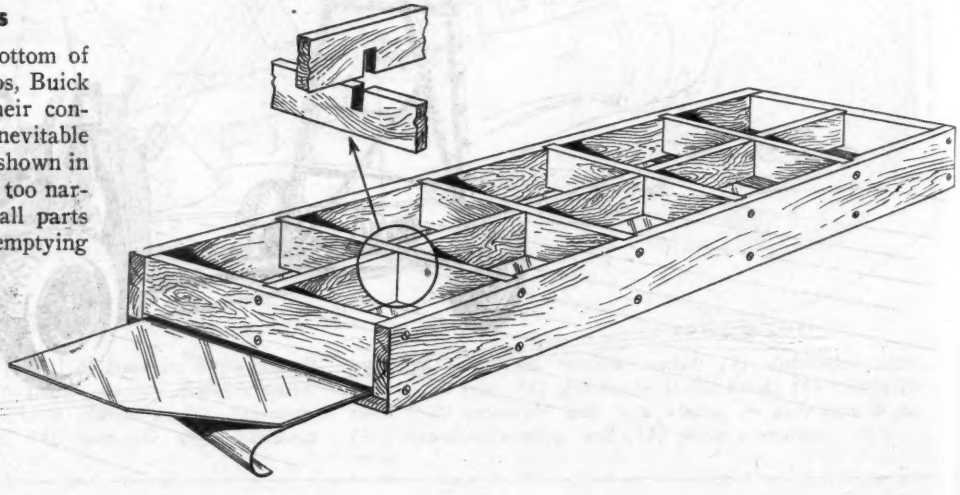


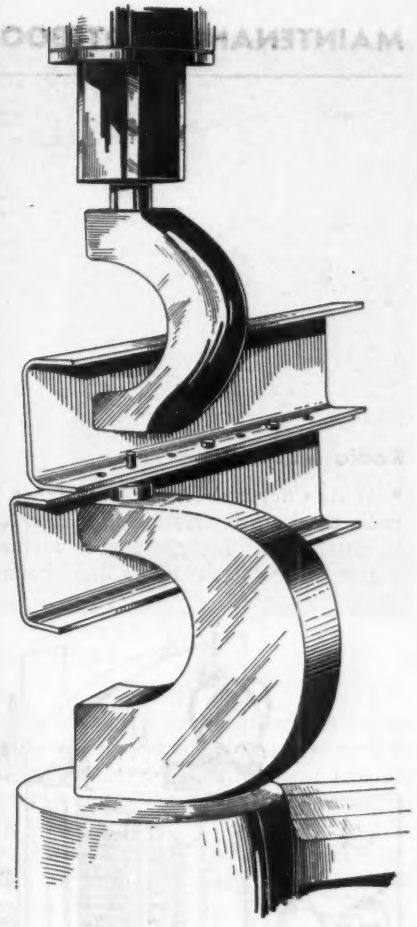
Aileron Lock Bar

• A U-shaped plastic casting (set around vertical wheel spoke in drawing) weighing little more than ½ lb., has been designed by Glenn L. Martin engineers to lock *Mariner* ailerons and elevators when these craft are not in air. Applied at control wheel, this bar yoke of an original plastic design attaches to lock bar by chain and hangs free when not in use. When locked, a slot in back of yoke engages lower spoke of wheel, while yoke itself fits around control column and into locking plate which holds it in position. Sketch shows yoke in locked position inside control wheel at left, with chain running from it to lock bar, which extends between two wheels.

Easy-Cleaned Parts Boxes

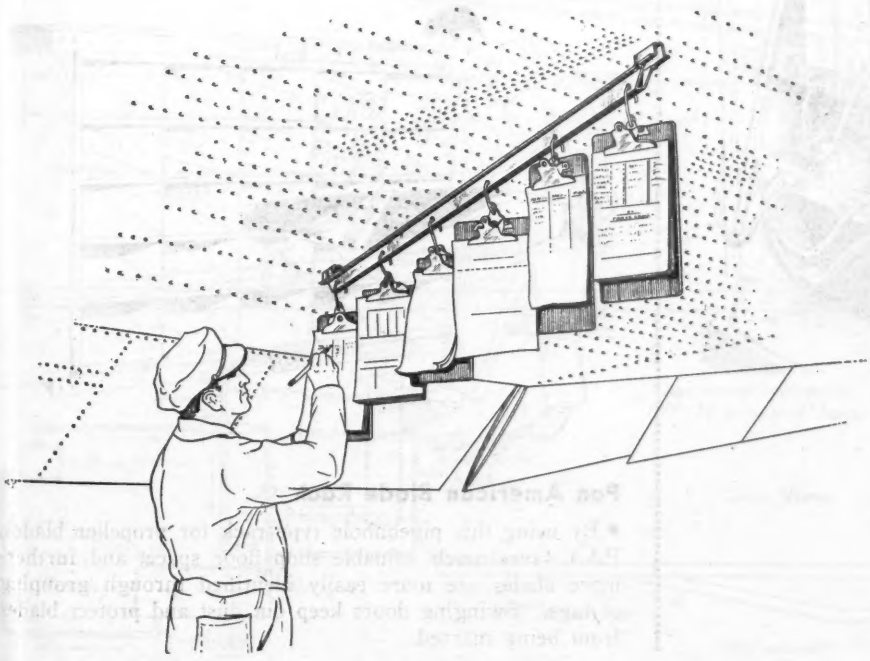
• By placing stiff paper in bottom of small parts boxes used in shops, Buick keeps these containers and their contents free from otherwise inevitable accumulation of dirt. Paper (shown in two layers) slides through slit too narrow to permit passage of small parts and can be renewed without emptying box.





"C"-Shaped Adaptors For "One-Shot" Rivet Machine

• Ray M. Williams, Northrop mechanic, designed these "C"-shaped adaptors. For use on "one-shot" rivet machine, they are of great aid in assembling difficult sections, such as riveting two narrow channels together (inside flange to inside flange, as shown), or for "Z" and hat sections, or other formed parts.

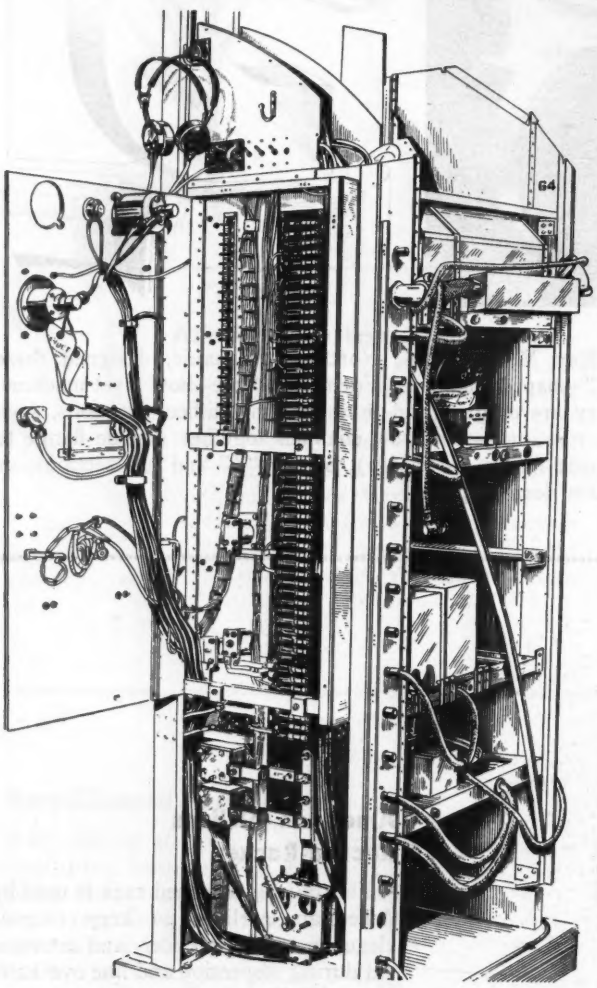


American Airlines Record-Racker

• This quickly attached rack is used by American Airlines to keep records clean, in sequence order, and convenient during inspection and line overhaul. It would otherwise be necessary to provide a portable desk for this purpose.

Radio Mock-Up

• At its Cheyenne shops, United Air Lines uses this radio mock-up for testing *Mainliner* equipment prior to installation. Incorporated is wiring for both sending and receiving, as under flight conditions.

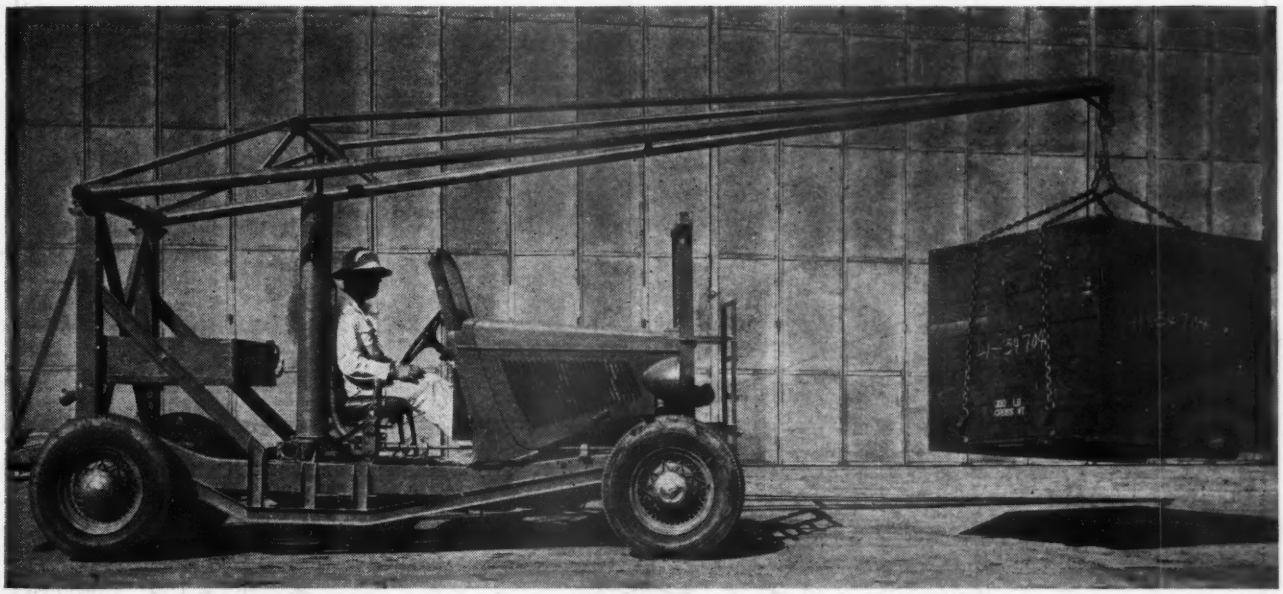


United's Hydraulic Tire Remover

• At UAL's Salt Lake shops, Bill Pitt is seen operating hydraulic tire remover, which he built from converted jack and welded steel frame. This tool has worked so well that United has adopted it at all repair stations, saving time, wheels, and tires.

Pan American Blade Rack

• By using this pigeonhole type rack for propeller blades, PAA saves much valuable shop floor space, and furthermore blades are more easily identified through grouping of tags. Swinging doors keep out dust and protect blades from being marred.

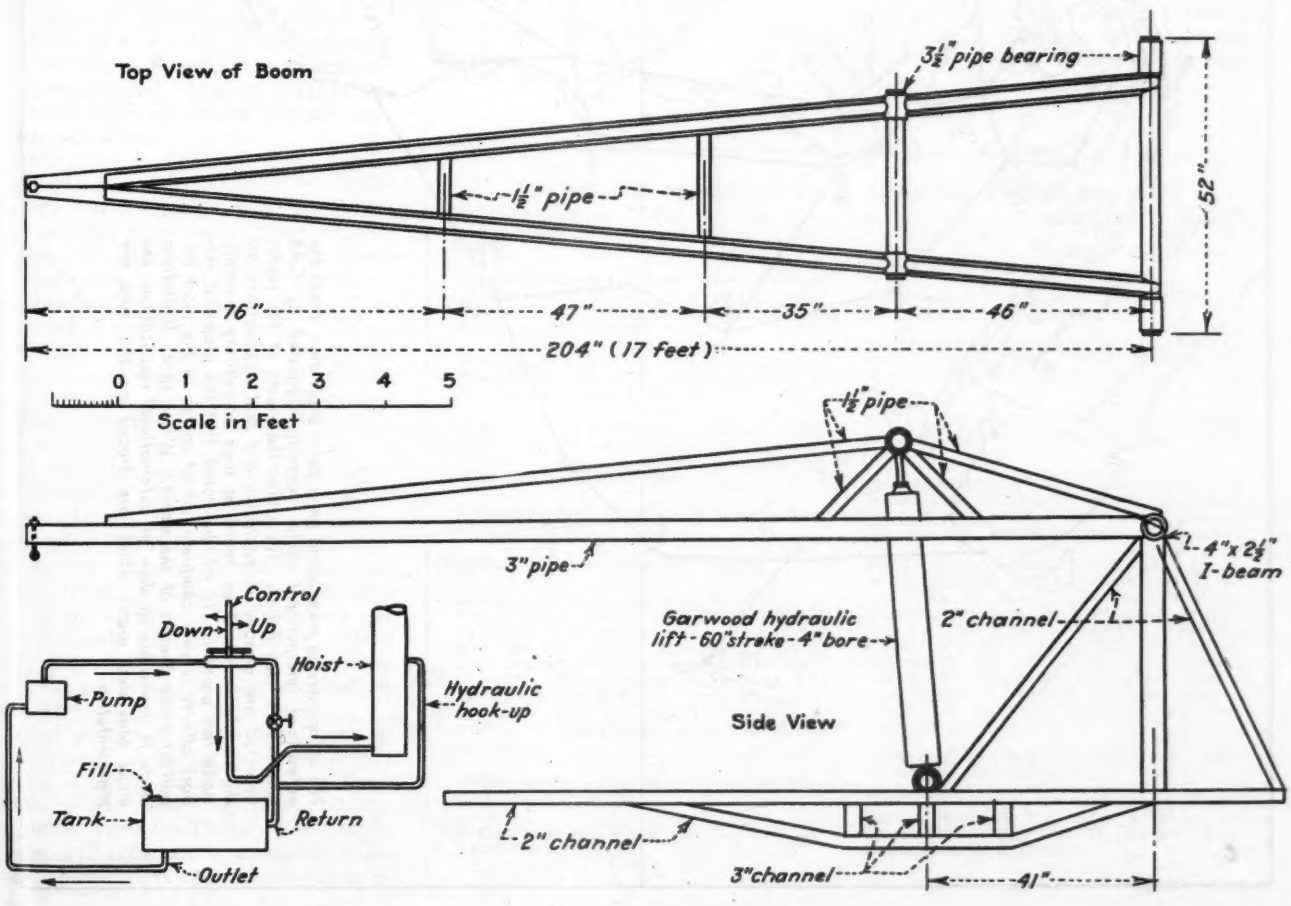


Ryan Hydraulic Hoist Car

• This hoist was built on a Ford V-8 chassis purchased second-hand for $75. After completely stripping chassis, except for hood and windshield, channel steel reinforcements were welded on each side, with cross pipe to form bearing for Gar Wood hydraulic cylinder. This cylinder, with necessary accessories, cost about $90.

Main members of boom are of 3-in. steel pipe cut about 17 ft. long. Front ends are tapered and welded together. At rear is cross pipe serving as pivot for boom when raising. Bearings at ends are 3½-in. pipe welded in place on framework, being kept in line while welding by insertion of 3-in. cross pipe. Radiator is protected by guard, and rest for boom is provided over hood to enable it to be fastened down when traveling any distance.

Oil pump for hoist is run by shaft extending back from V-belt drive at front of engine. This useful piece of equipment was designed and built by Ryan School of Aeronautics. Drawings show specifications.



The accompanying map, based on a polar projection, shows the network of international routes recently suggested by CAB Chairman Welch Pogue. He states that some of the routes depicted are already in operation and that applications for the remainder would be heard as soon as military necessity made this possible. It will be noted that the proposed network affords a very complete set of routes to the most important trade centers of the world. While space limitations made it impossible to show all international applications, the many requested routes which are traced on this map are representative.

Three International Policies —*Which Will We Have?*

By A. A. HARTSINCK

With no clues as to what government policy may be, U. S. airlines express their own views which, despite their typical American divergencies, all point toward the same goal.

FOR MORE THAN HALF A YEAR, the airlines of this country have been anxiously waiting for some official pronouncement from the government on postwar international commercial air transport. And while there have been a number of semi-official conferences with Lord Beaverbrook of England, both in London and Washington, and such preliminary talks are now again going on with representatives of Russia and China, there still has not been any indication as to the "shape and form" which the U. S. Government wishes the airlines to aim for in planning their postwar services.

There have been any number of statements by both British and American officials, most of them confused and confusing: Freedom of the air? No—strict regulation of all services. International regulation of all air services by one body? No—individual authority by each country, absolute and complete. These are just a few of the opinions which have been widely publicized.

Small wonder, therefore, that the airlines of this country, perplexed and disappointed, have begun setting forth their own opinions and plans. Completely in keeping with the individuality of American enterprise, all the airlines could not get together on one plan. Some 17 of them—all domestic lines except United, plus American Export—have formed a political action committee, headed by Samuel Solomon, president of Northeast Airlines. This group advocates open competition.

On the other side of the fence stands Pan American Airways, pioneer of the United States' international airlines—in favor of a "chosen instrument" policy, the precise chosen instrument not yet being directly indicated. On the same side of the fence as Pan American, but with distinctly different views, is United Air Lines, advocating a "U. S. Flag Airline," made up by cooperation of all lines, each assigned distinct zones.

In an attempt to throw some light on this situation, AVIATION is herewith presenting complete details on these three rather widely separated views on the manner in which the United States should obtain, and maintain, a prominent position in postwar commercial air transport outside the United States. These views are presented together for the first time as a comprehensive over-all picture of postwar plans.

Which of the three methods will be used is a matter which, eventually, will be decided upon by both the CAB and the State Department, probably after the long-heralded international air conferences have been held late this year or early in 1945.

The policy adopted by the 17 airlines—American, American Export, All American, Braniff, Chicago & Southern, Colonial, Continental, Delta, Eastern, Inland, Mid-Continent, National, Northeast, Northwest, Penn Central, TWA, and Western, can briefly be stated as calling for—

1. Private ownership of all airlines and private management, free from government direction or interference.

2. Encouragement and development by this country's government of a well-based and worldwide air transportation system.

3. Complete and open competition, without geographical restriction, subject if necessary to some form of regulation by suitable governmental agencies.

4. "Freedom of transit" on a worldwide basis, and,

5. Establishment of such civil and commercial outlets as are required in the public interest.

The points set forth above comprised, more or less, a reply to the series of questions sent all airline operators early last year by the Civil Aeronautics Board, also supplemented direct statements made to that governing body by the airlines in question. The group does not advocate duplication of effort along routes, except where traffic potentials exist which would support more than one or two airlines. The matter of assigning routes would be left strictly to the CAB along lines already laid down, limited by the commercial rights which this country has and will acquire from foreign nations.

A very important point set forth by this group of airlines is its insistence that this country retain certain rights

(*Turn to page 274*)

International Applications by U. S. Airlines Through June 1944

American—New York, Boston, Chicago, and Detroit to London and Paris.

American Export—New York, Boston, Chicago, and Washington to Bermuda, Puerto Rico, Capetown, Rome, Sevastopol, and Bombay.

Braniff—Ft. Worth to Rome, London, Stockholm; Houston to Balboa, Rio de Janeiro, Buenos Aires.

C & S—New Orleans to Havana, Balboa, Port of Spain, Rio de Janeiro, Buenos Aires; Chicago to Batavia; Houston to Mexico City.

Colonial—New York to Bermuda, Nassau, and Port of Spain.

Delta—New Orleans to Havana.

Eastern—New Orleans to Mexico City, and Balboa; Miami to Nassau, Ciudad Trujillo, Rio de Janeiro, Montevideo, and Buenos Aires; Boston to Nassau, and Ciudad Trujillo; Houston to Mexico City; Washington to Ottawa and Montreal; any point or series of points in U. S. with any point or series of points in Caribbean area or Latin America.

Hawaiian—Honolulu to Los Angeles and San Francisco.

Inland—Great Falls to Bethel, and Alaska.

National—New Orleans, Tampa, Miami to Havana, Santiago, Mexico City, and Balboa, Rio de Janeiro, Montevideo, and Buenos Aires.

Northeast—Boston to London, Paris, Prague, and Moscow.

Northwest—Chicago to Nome, Manila, and Calcutta via China; Seattle to Nome, Manilla, and Calcutta via China.

Panam—Belem to Miami; San Juan to Charleston, Baltimore, and New York.

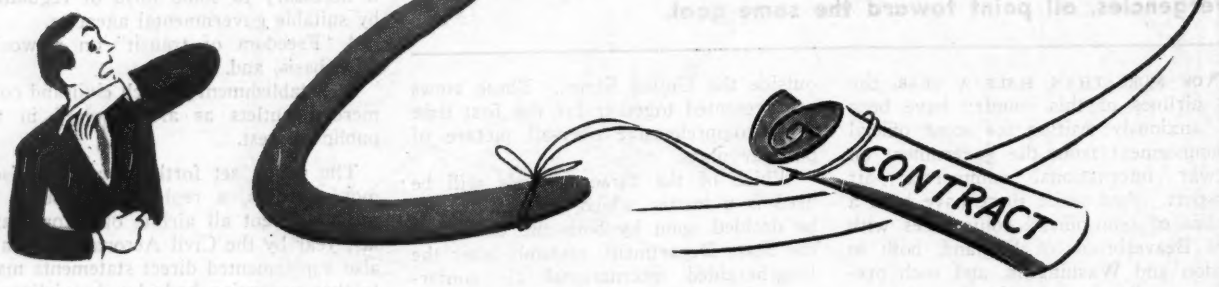
Penn-Central—U. S. to England via Seadromes; Miami to Barranquilla, and Port of Spain; New Orleans to Belize, and Port of Spain; Buffalo to Ottawa.

TWA—Los Angeles to Honolulu; U. S. to Greenland, Iceland, Scotland, London, Paris, Berlin, Venice, Vienna, Budapest, Belgrade, Bucharest, Istanbul, Athens, Cairo, Bagdad, Teheran, Kabul, Karachi, New Delhi, Calcutta, Mandalay, Hanoi, Canton, Chungking, Lanchow, Hankow, Shanghai, Tientsin, Peiping, Mukden, Harbin, Tokyo, Attu, Kiska, Dutch Harbor, and Anchorage.

United—Cleveland to Montreal; San Francisco to Honolulu.

Western—Seattle to Anchorage, Fairbanks, and Nome; Los Angeles to Buenos Aires and Rio de Janeiro; San Francisco to Honolulu.

CONTRACTS WITH MINORS CAN BOOMERANG



By **LESLIE CHILDS,** *Attorney and Counsellor at Law*

The law makes strange provisions for persons who "aren't of age" —which means aviation organizations must exercise great care in signing contracts with under-21'ers.

WITH WTS CONTRACTS being cancelled right and left, more and more fixed base operators are again turning to civilian training as a means of keeping the wolf out of the hangar.

But, it should be remembered, civilian training has its pitfalls. One of the easiest ways for a flight school—or any other aviation organization, for that matter—to get into a peck of trouble, and perhaps suffer material financial loss, is to have contractual dealings with persons who are minors.

This is because, as a general rule, a minor's contract for anything save necessities are voidable. According to law, if a minor changes his mind after receiving the benefits of such a contract, he may disaffirm and demand return of whatever money he has paid.

The application of this rule, and the possible danger to an aviation organization in running afoul of it, is strikingly shown in this actual case—

The plaintiff, a youth 20 yr. and 2 mo. old, contracted with a corporation operating a flight school for a primary flying course. The youngster paid $300 and took the course.

Then, still before he had become 21, the youth also took a limited commercial pilot's course, for which he paid $1,300. He completed this work before reaching his majority.

About a year later—after he had become 21—he brought an action against the flight school corporation to recover the $1,600, the grounds for the suit being that he had been a minor when entering into the contracts, thus could disaffirm.

The flying school's defense was based on the contention that the instruction had been "necessary," by way of education, for which the plaintiff should be held liable even though a minor. The defense also held that, since the plaintiff could not return what he had received, i.e., instruction, he should be held to his contract.

Holds for Plaintiff

The lower court held for the plaintiff. Then the case went, on appeal, to a higher court which, in reviewing the record and upholding the youth, said in part:

"It is agreed that the contracts were made in New York where the defendant's aviation school was located, also that the questions raised in the case are governed by the laws of New York . . .

"The defendant contends that the contracts were for necessaries and were binding on the plaintiff even though he was a minor. Plaintiff's father was a weaver. The money which the plaintiff paid was in part saved by himself from his manual labor and in part contributed by his family from their savings . . .

"It would be hard to say that education in aviation was less necessary for the plaintiff than it would have been for another more affluent. But the law still guards the interests of minors against their own assumed improvidence and want of sound judgment. The judge found that the courses in instruction were not necessaries for the plaintiff . . .

"Lastly, the defendant contends that there can be no disaffirmance because the plaintiff could not return the instruction he had received by virtue of the contract. In New York, as in this Commonwealth [Massachusetts] a minor who has lost or even squandered what he received under the contract may nevertheless disaffirm it and recover whatever he paid or gave, or its value . . .

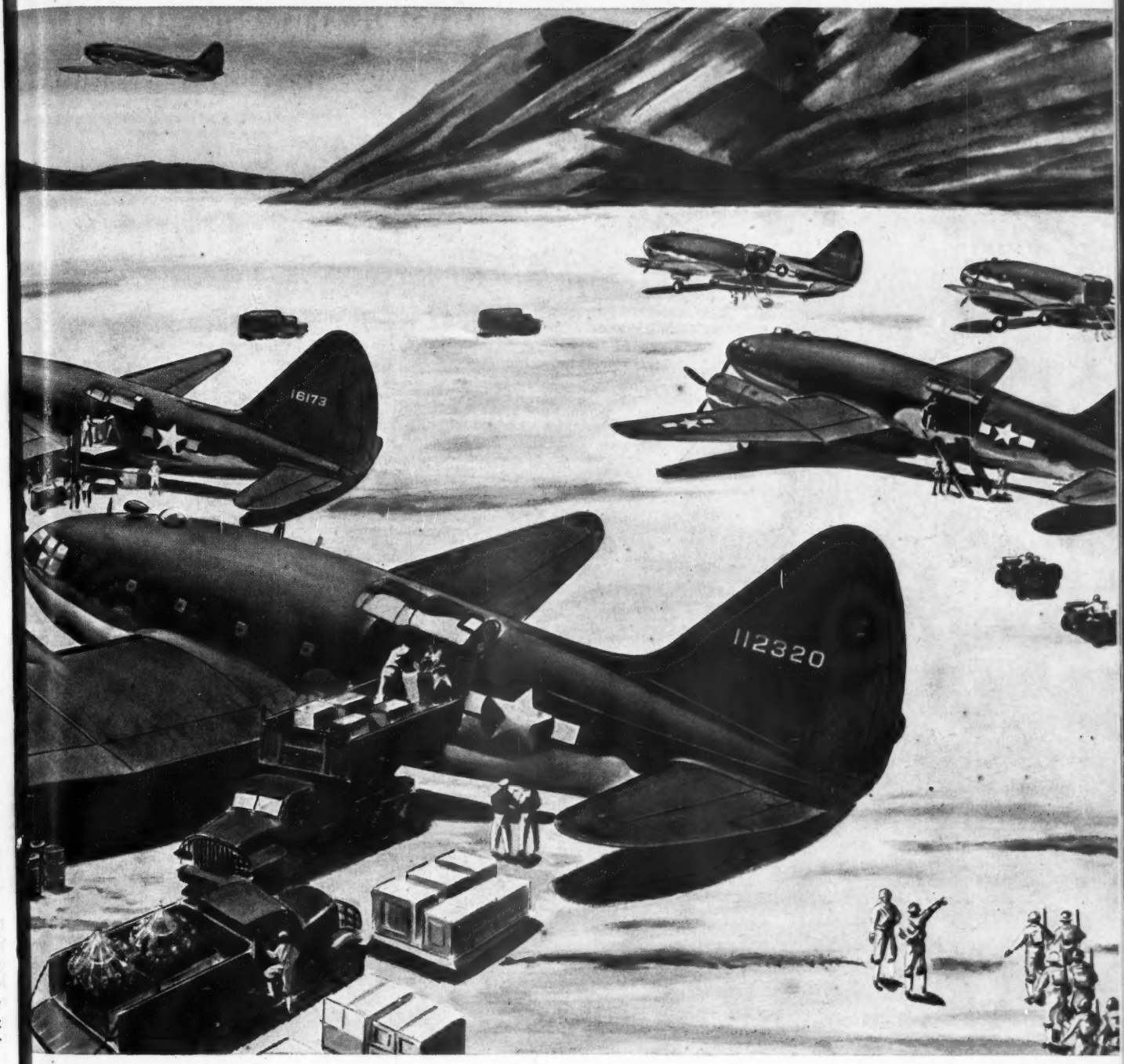
"On the whole . . . we think that under the law of New York the plaintiff is not precluded from disaffirming the contract and recovering the consideration he paid . . . Judgment for plaintiff on the findings. (14 N.E. 2d 467.)"

—All of which meant that the flight school operator had to return the $1,600. The fact that the plaintiff couldn't return the instruction received constituted no bar to his recovery.

Under different circumstances—had the plaintiff been a wealthy young man, for example—the two courses of instruction he had received might have been held to be necessaries, but the reasoning and final holdings in this case are both in accord with the great weight of authority.

And, as an illustration of the possible danger to a flight school or any other aviation organization in contracting with a minor, this kind of a case is hard to beat.

THAT OUR COUNTRY MIGHT *Out-Maneuver* THE ENEMY



Curtiss C-46 Commando Transport!

With the war in high gear, speed is the essence of victory! No nation can hope to wage global warfare and win without a means of moving vast numbers of men and a tremendous tonnage of supplies, long distances at high speed.

The Curtiss C-46 Commando Troop and Cargo Carrier has admirably met this demand for unprecedented mobility.

Today the Commando is a part of the greatest military transport program ever inaugurated. Tomorrow it will fly supplies for the rehabilitation of the world. Hard on the heels of victory, too, will come the Commando's conversion to both a luxury liner and a commercial cargo carrier for civilian service. LOOK TO THE SKY, AMERICA!

Another Contribution of

Curtiss-Wright
Corporation
AIRPLANE DIVISION

Toward Winning This War

BUFFALO · COLUMBUS · ST. LOUIS · LOUISVILLE

Member, Aircraft War Production Council, East Coast, Inc.

From our bomber plant in Georgia are coming B-29 Super-fortresses.

First American jet propelled plane, designed and built by Bell Aircraft.

The Bell Airacobra helped turn the tide at Stalingrad and on other fronts.

On many planes and ships are the Bell designed flexible gun mounts.

Preview of the new Bell fighter—as it will be seen in action by the Axis.

The Bell Helicopter—adaptable for many missions of war and peace.

Bell Aircraft at War

. . . A PROGRESS REPORT

A good fighter plane—basic in modern military operations—must pack plenty of wallop. That's why Bell Aircraft developed its hard-hitting Airacobra around a 37-millimeter cannon firing right through the nose of the plane.

This "cannon-on wings"—first American single-engine fighter to carry a cannon in the skies—has turned in a performance which caused the Russians to tell WPB Chairman Donald M. Nelson the Airacobra was one of the American products they liked best. And today the Airacobra is being joined by a new Bell fighter, capable of high-speed, high-altitude performance.

Building such fighter planes is only one part which Bell Aircraft is playing in the war. On another front, the Bell Bomber plant in Georgia is producing the Boeing designed Super-fortresses (B-29's), largest long range bombers ever seen. And from our Ordnance Division in Burlington, Vt., come Bell designed gun mounts, including the new hydraulic power mount, that give the machine guns of many allied planes and surface ships their firing accuracy.

Meanwhile work is continuing on two other war projects, America's first jet propelled plane, and the new Bell Helicopter.

Post-war activities are being locked in our minds until the day of Victory. Then our organization, staffed with production men of skill and imagination, will turn their thoughts to pioneering in an aviation world at peace.

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MEMBER AIRCRAFT WAR PRODUCTION COUNCIL—EAST COAST, INC.

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

Niagara Frontier Division, Buffalo and Niagara Falls, N. Y.—Ordnance Division, Burlington, Vt.—Georgia Division, Marietta, Ga.

BUY WAR BONDS AND SPEED VICTORY

Southwest Flies 1,000,000th Training Hour

Civilian organization gives flight instruction to more than 15,000 embryo sky fighters.

LESS THAN FOUR YEARS after initiating training for civilian flight instructors at Sky Harbor, Phoenix, Ariz., as the basis for its part in the War Training Service program, Southwest Airways became one of the first schools to pass the millionth hour of military pilot training flying time.

One million hours, translated into miles flown, would carry an airplane around the world 3,452 times at the equator. In fact, it is enough flying time to send a 661,980-airplane armada on a mission from London to Berlin. Incidentally, approximately 4,638,600 takeoffs and landings were included in that time.

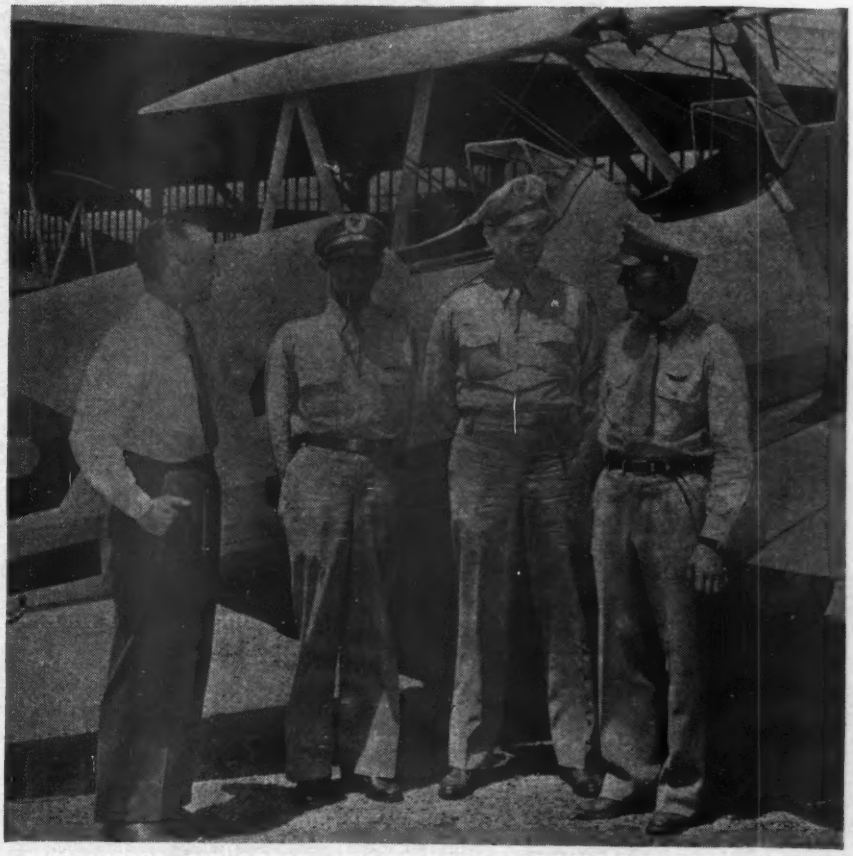
Primary training has been given to more than 15,000 students at Southwest. In addition to student pilots of the Army Air Forces, instruction has been afforded to other nationals representing 29 countries, including every Chinese student sent to this country for primary training. RAF students have received primary, basic, and advanced training.

With the first rush of the AAF's rapid expansion program, Southwest Airways, as a preparatory step, began its WTS instructor school at Sky Harbor in Oct. 1940; today, Southwest's staff has some 400 flight instructors who have spent nearly half of the 1,000,000-hr. total in the air with students.

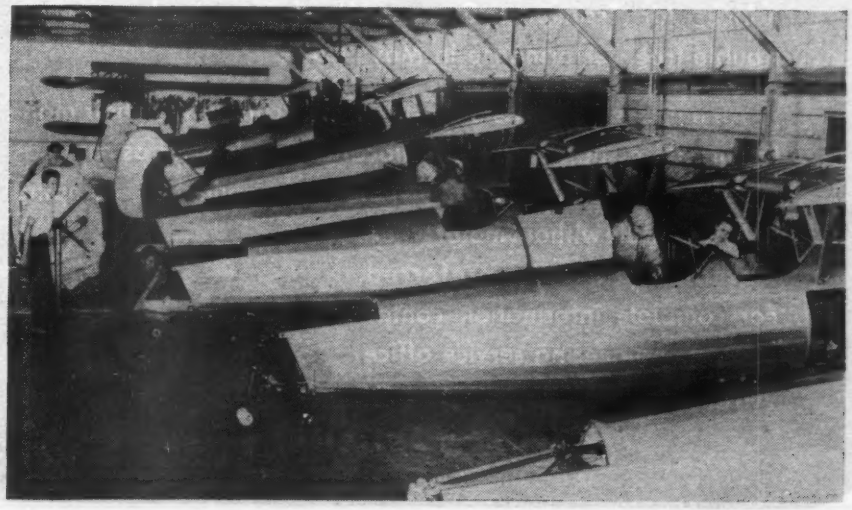
First training flights for students were inaugurated at Thunderbird Field in Mar. 1941, with subsequent expansion of activities at Falcon Field and at Thunderbird II. From operations involving three airplanes, Southwest has grown to base more than 500 aircraft of all types.

And to cope with the huge maintenance problems presented, a "production line" aircraft and engine overhaul unit was developed.

In its intensive training program, Southwest has maintained a record of safety which ranks with the best in the nation—as witness Thunderbird Field with only one fatal accident per 167,000 hr. flown.



Jack Connelly (left) co-founder and president of Southwest Airways, checks with pilots just before they take off to fly organization's millionth hour. Pilots (left to right); Ralph Jordan, Al Storrs, and Cliff Davis. All of these men were associated with company when it flew its first hour and each is a director of training—of Thunderbird, Falcon, and Sky Harbor, respectively.



Maintenance is handled by "production line" aircraft and engine overhaul unit. Splendid record of safety achieved by Southwest in intensive flying training program is due in large measure to this maintenance activity.

AN 6100—1 (ANP—1 and ANP—2)
ADEL Series "K" gear type direct drive Fluid metering Pump. Weight 2.75 lb.—Cap. 2.5 to 30 GPH dual or single outlet. Tested —65° F. to +200 F. Industrial capacities to 200 GPH.

☆ *Meets . . .*
AND *exceeds* AN SPECIFICATIONS

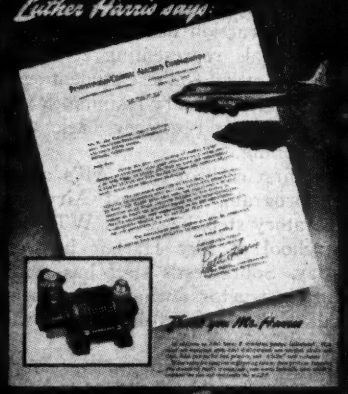
Whether for anti-icing or for heating, this pump exceeds all existing performance requirements. Test run of 1313 hours—over 8 times the requirements and still going strong! Little wonder that it received AN rating. Backed by years of service of 75,000 predecessor units starting with the original ADEL Series "E," introduced in 1938 as the *first* designed specifically for U. S. Air Lines' protection of wind shields, propellers, carburetors.

Value to cost-conscious commercial operators was long ago affirmed by Mr. Luther Harris, P. C. A. Vice-President Engineering and Maintenance (now Col. Harris, Chief of Maintenance, Air Transport Command) who praised capacity, trouble-free performance in May, 1940.

An entire ADEL division is devoted exclusively to their manfacture. Not subject to ASU allocations. Deliveries as rapid as raw materials availability. For industrial application, pumping units available without motor where mechanical drive is preferred. For complete information contact nearest engineering service office.

After Victory the ADEL-AGE

Luther Harris says:



ADEL PRECISION PRODUCTS CORP.
[illegible] SOUTH OLIVE AVENUE, BURBANK, CALIFORNIA

Industry's Sales Soar . . . But Not Profits

By RAYMOND L. HOADLEY, *Financial Editor, "Aviation"*

In his annual survey our financial editor finds the aircraft makers' financial condition much sounder — better than the perplexed investor might realize as he eyes the "stabilized" income.

WARPLANES may be coming off aircraft assembly lines in ever-increasing numbers, but profits of the industry have long since become stabilized around the 1942 levels.

The average aircraft maker's 1943 earnings were slightly below those of 1942, and stockholders can expect that this year's results will run about the same, depending, of course, on contract cutbacks and the time lag in shifting to new war orders.

But while profit margins decline in inverse ratio to the sales climb, a survey of the 1943 statements of 14 aircraft manufacturers reveals that much progress was made last year in brightening what had been a pretty gloomy financial picture. We would have preferred to have included more companies in the survey, however as this was written several like Curtiss-Wright, North American, Grumman, and Fairchild were still holding up their reports because of renegotiation problems.

The companies surveyed, though, are thoroughly representative of the industry. There are plenty of bad spots left in the industry's financial set-up, as will be shown. Yet the over-all picture at the 1943 year-end shows sufficient improvement to indicate that the nation's biggest wartime industry will stay solvent during its critical peacetime reconversion period.

That's something we weren't able to predict with too much confidence a year ago.

Here, in a nutshell, is the way the industry's financial cards stacked up at the beginning of 1944: For the first time since Pearl Harbor the average company's cash position was larger than the taxes it owed; postwar adjustment reserves increased some 60 percent last year (although they're still inadequate); and current assets were up more than were current liabilities. Inventories and bank debt were higher, while the profit margin on sales was the lowest of all America's great industries except one (meat packing).

Now for a more detailed review and interpretation of the aircraft financial facts of 1943, plus a glance into the immediate future:

Sales of all but one of the 14 government contractors covered in this annual survey amounted to $4,870 millions last year against $3,300 millions in 1942. Deliveries of the same group this year may well run better than $6 billion.

On the other hand, net earnings of the group were $83,346,790 last year against $81,590,440 in 1942. This figure, though, is a bit deceptive, since in nearly all instances (United Aircraft is a notable exception) the companies have yet to get their renegotiation clearance papers on their 1943 results. When they do get through the renegotiation mill it probably will be found that 1943 profits actually will be a bit under their renegotiated earnings of 1942.

An exhaustive study of the 1943 corporate earnings of more than 2,500 companies recently made by the National City Bank of New York showed that an average of 3.6 percent was earned on sales after taxes were deducted. This represented a decline from 4.3 percent for 1942. But the aircraft group showed an average return of only 1.8 percent, down from 3.2 percent in 1942.

Not only was the aircraft industry's margin on sales well below that of American industry generally in both years but it also was next to the lowest of any individual group. The meat packing industry had a profit margin on sales of 1.1 in 1943 and 1.2 in 1942. In contrast the automobile industry, which is largely engaged in aircraft work at present, showed an average profit margin of 3.2 percent on sales in 1943 and 5.2 in 1942.

In addition to the voluntary refunds (running up into hundreds of millions of dollars) which the industry returned to the government last year, the 1943 tax liability of the 14 concerns studied reached the amazing total of $336,946,000—more in taxes than the industry had in sales four years ago. But while taxes were stepped up from the $285,955,000 paid in 1942, there was one phase of the tax pic-

(*Turn to page 271*)

COLLATION OF 14 COMPANIES' 1943 STATEMENTS

	Sales		Net Earnings		Net Purchase		Dividends		Inventories (in thousands)	
	1943	1942	1943	1942	1943	1942	1943	1942	1943	1942
Aviation Corp.	$72,621,507	$45,530,638	$3,519,437	$4,723,894	$0.61	$0.82	$0.20	$0.25	$12,096	$6,791
Beech	126,578,384	59,592,953	4,035,965	2,417,819	7.24	5.93	1.00	1.00	13,183	21,331
Bell	232,134,628	121,863,227	2,462,414	1,711,583	6.24	4.80	1.00	2.00	5,229	4,454
Boeing	493,188,000	386,567,000	4,482,870	5,237,000	4.14	4.84	2.00	1.00	2,742	4,594
Cessna	70,729,401	11,782,060	2,208,414	738,202	6.31	2.11	1.00	1.00	7,988	15,459
Consolidated Vultee	797,199,000#	831,295,000	19,267,000	20,875,000	13.76	14.88	1.50	1.00	158,280	101,464
Douglas	987,687,196	489,781,985	5,952,257	9,229,620	9.92	15.38	5.00	5.00	12,880	17,305
Jacobs	14,652,600	12,989,000	1,519,465	2,961,460	2.46	4.79	(none)	(none)	5,518	4,983
Lockhead	667,680,690	460,233,000	7,988,420	8,163,721	7.42	7.59	2.00	2.00	50,620	38,657
Martin	632,163,870	337,556,000	12,437,583	6,658,809	5.57	5.93	3.00	1.50	95,166	121,297
Piper	11,478,597	5,307,749	315,259	115,865	2.17	0.76	(none)	(none)	1,485	1,287
Republic*	.....	.....	3,025,954	1,105,061	1.20	0.63	0.25	(none)	1,758	5,548
Ryan	19,705,525	16,306,888	597,313	556,444	1.36	1.27	0.35	0.55	5,644	2,557
United	736,638,984	521,748,413	15,396,114	17,096,000	5.30	5.95	3.00	3.00	68,854	53,559

* Sales not available. # 1943 sales after government refunds.

He learned to fly in World War I, without a parachute. He never had a crack at a Hun or a medal, felt that his wings were honor enough. When Uncle Sam gave him a sixty buck bonus and a ticket home, he couldn't go back to the old life—saw his future in flying.

Or maybe he was too young for the War, and hung around hangars with his heart in his eyes until he could trade odd jobs for stick time.

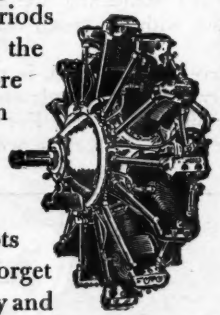
He slaved and saved to own a plane—an Army relic, a rebuilt crash job, a homemade copy. He gave lessons, sold rides, barnstormed, flew in prize meets; carried the mail; sometimes hit the headlines flying serum to a sick baby. But he wasn't a glory hound; just wanted to make a living flying—and often died at it.

If the crate acted cranky or the motor quit, he couldn't tell the crew chief or Maintenance. Maintenance was his affair—or his funeral.

He needed an engine that didn't need a nursemaid . . . one that was easy on gas, simple enough that he could service it, up to hard work and hard knocks on cowpasture airports.

Jacobs gave him such an engine, and later better and larger versions. Our first customer and severest critic, he and Jacobs together developed the workhorse of plane engines.

When the war came, the Jacobs was a natural for the bi-motored trainers, sure and safe for student pilots. On training fields from Canada to Cape Horn, the Jacobs takes more take-offs and full throttle time than any engines in combat . . . yet ran up their service periods between major overhauls from the originally specified 350 to more than 1,000 hours. Helped train fine bomber pilots fast, and cut costs for taxpayers!



We hope that these new pilots and their proud parents will not forget . . . how much of the speed, safety and success of this vast training program is due to the breed of men who believed and lived and worked to make airpower feasible . . . though many of them never survived to see the fact! . . . Jacobs Aircraft Engine Co., Pottstown, Pa.

JACOBS. Pottstown, Pa.

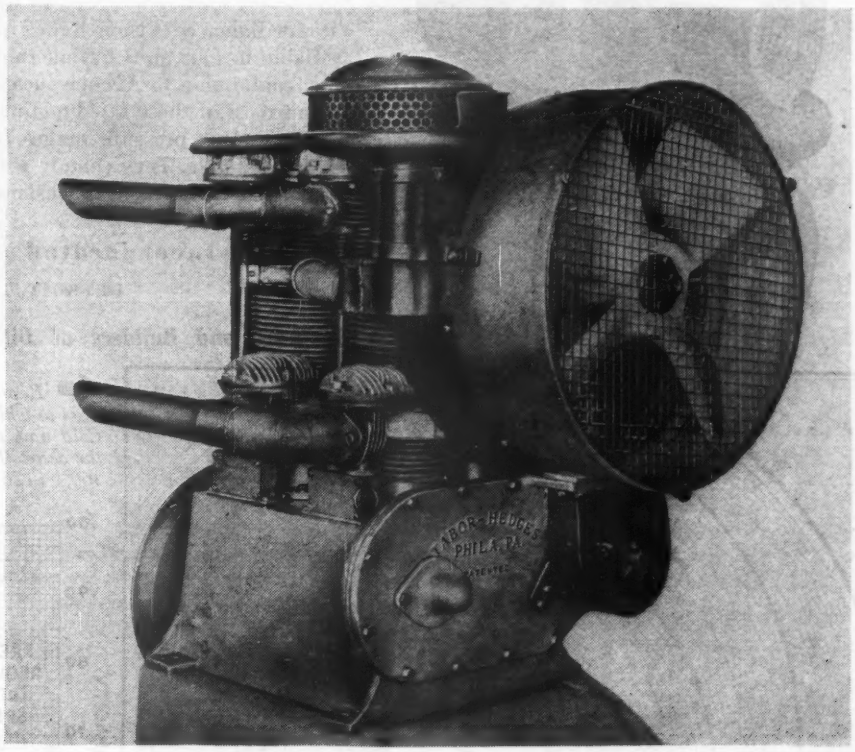
New Auxiliary Engine Gives More Power-Per-Pound

Use of double-acting principle said to save 30 percent weight; unit designed for ground as well as air applications.

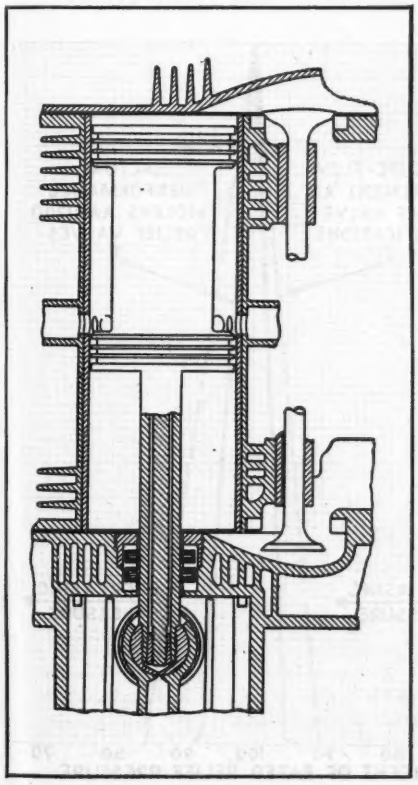
TO MEET THE NEED for larger auxiliary power plants for military and commercial aircraft as well as for ground uses, Tabor Mfg. Co., Philadelphia, has developed a new two-cylinder aircooled engine designed to deliver a maximum of 32 hp. at 2,200 rpm. Utilizing the double-acting principle, this Tabor-Hedges engine is said to weigh at least one-third less in pounds-per-horsepower than conventional four-cycle engines currently being built.

While the weight ratio is a dominant factor in aircraft applications, the engine is held to be adaptable for furnishing starting power, for lighting or fire-fighting equipment, or as an auxiliary unit in boats or other surface installations where light weight is desired.

Cooling, heretofore one of the most serious problems of double-acting internal combustion engines, is said by the manufacturer to have been eliminated by drawing off approximately one-third of the excess heat from inside the cylinder. This is done by pulling carburetor air through the pistons, although the same results could be obtained by using a separate blower if, for any reason, it was undesirable to pre-heat the combustion air.



Tabor-Hedges double-acting auxiliary engine, developed for ground as well as aircraft uses, is 26-in. high, 26-in. long, and 21-in. wide. It delivers 32 hp. at 2,200 rpm.



Cut-away drawing of Tabor-Hedges cylinder shows method of internal cylinder cooling. Air for carburetor intake is drawn through ports shown in cylinder center; piston walls are cutaway to flow of air around them.

This cooling action is made possible by the design of the piston which, in a double-acting engine, is in reality a double unit, with conventional rings top and bottom.

However, in the Tabor-Hedges plant, the piston is hollow and the walls are cut away on opposite sides to give a free flow of air through cylinder ports located midway between the heads. The cylinders are long enough so that the rings do not close the ports. Since this engine is the equivalent of a conventional four-cylinder type—both having two power impulses per revolution—there is a continuous flow of cooling air through the pistons. Inner sides of the piston heads are finned, and baffles are installed to direct cooling air to those points.

Outside cooling fins run full length of the cylinders from the top head to the crankcase, with extra fins around exhaust valves. A 16-in. four-bladed fan is enclosed in an aluminum cowling, from which 26-gage sheet steel fairing directs the flow of cooling air to the cylinders. The belt-driven fan travels at 1.2 times crankshaft speed.

New design techniques have been applied to the engine's crosshead. It consists of a wrist pin mounted at each end in ball bearings, the pin being securely attached to the piston rod, since the outer connecting rod bearing is forked to make this possible. Ball bearings run between

(*Turn to page 272*)

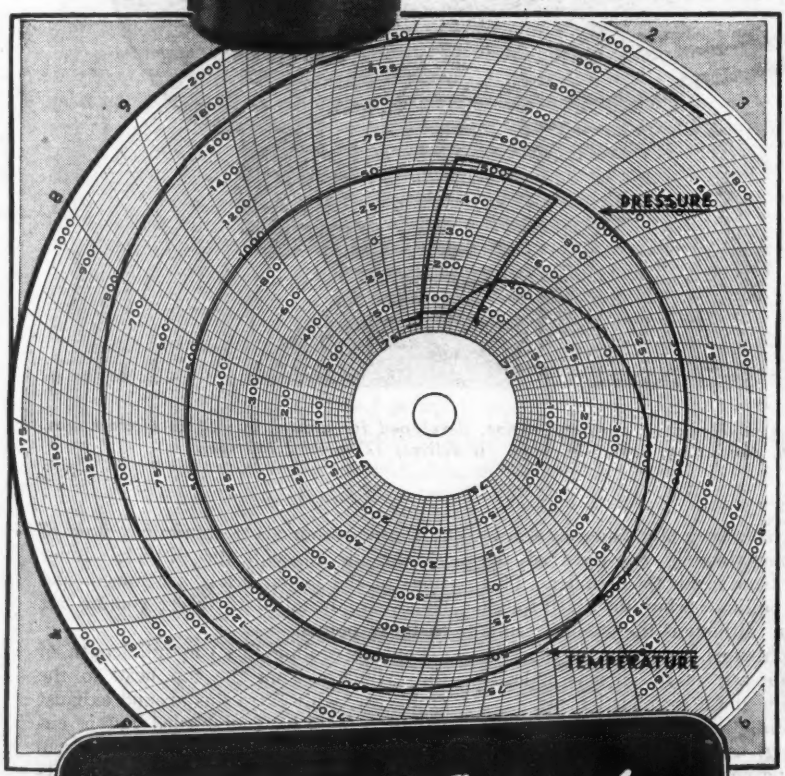
A *Better* RELIEF VALVE For Aircraft Hydraulic Systems

A pilot-operated piston is used in the Vickers Aircraft Relief Valve instead of the customary spring-loaded direct-acting mechanism. The result is smoother operation and geater accuracy throughout a wider range of pressure adjustment. Variation in pressure from cracking point of valve to its maximum capacity is negligible (see curves below).

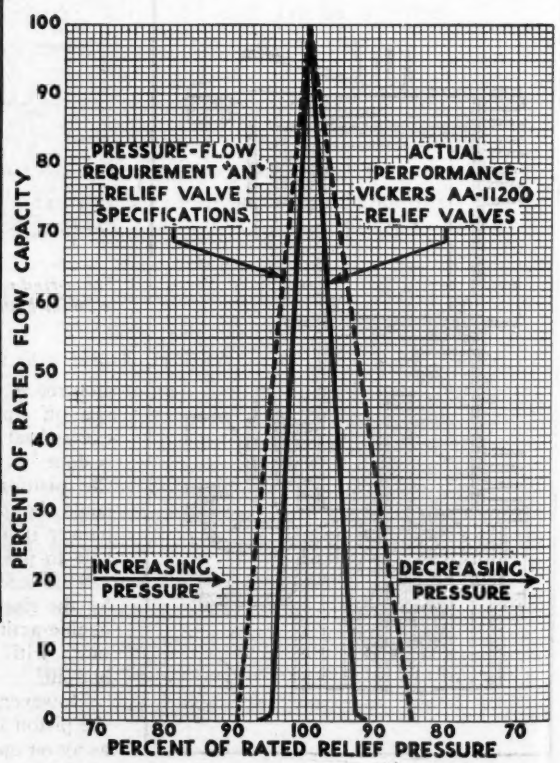
Vickers Balanced Piston Relief Valves (Model AA-11200 Series) are available in four sizes having rated capacities of 1.2, 3.5, 6.0 and 16 gpm, conforming to AN specifications. Actual capacities are, however, far in excess of these rated minimums. Without parts change all valves have operating pressure ranges from 300 to 2100 psi; adjustment is easy and simple. They comply with Winterization requirements of the Army Air Forces; their dimensions comply with the AN-6200 envelope.

VICKERS Incorporated · 1462 OAKMAN BLVD.
DETROIT 32, MICHIGAN

Engineers and Builders of Oil Hydraulic Equipment Since 1921

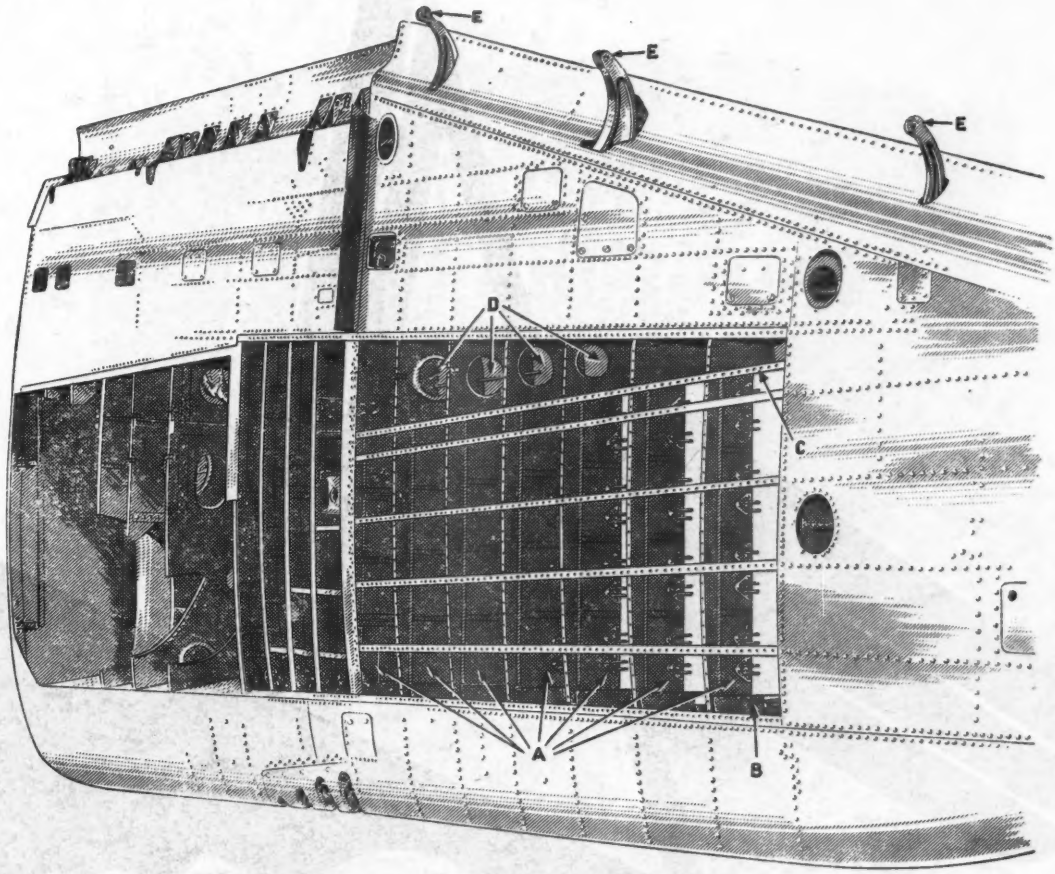


Representative of the exhaustive and severe tests to which these valves have been subjected is the Cold and Increasing Temperature Test recorded on the chart. The temperature increased from —65° F to 160° F in 26 minutes (one revolution of chart = 24 min.)

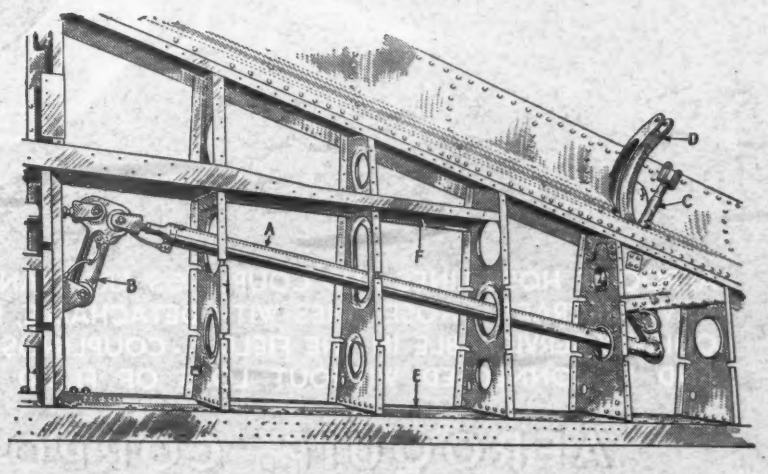


As indicated by the curves above, the variation in pressure from cracking point to maximum rated capacity of the Vickers Balanced Piston Relief Valve is considerably less than permissible under AN Standards. Consequently, less pressure differential is required between relief valve setting and unloading valve pressure.

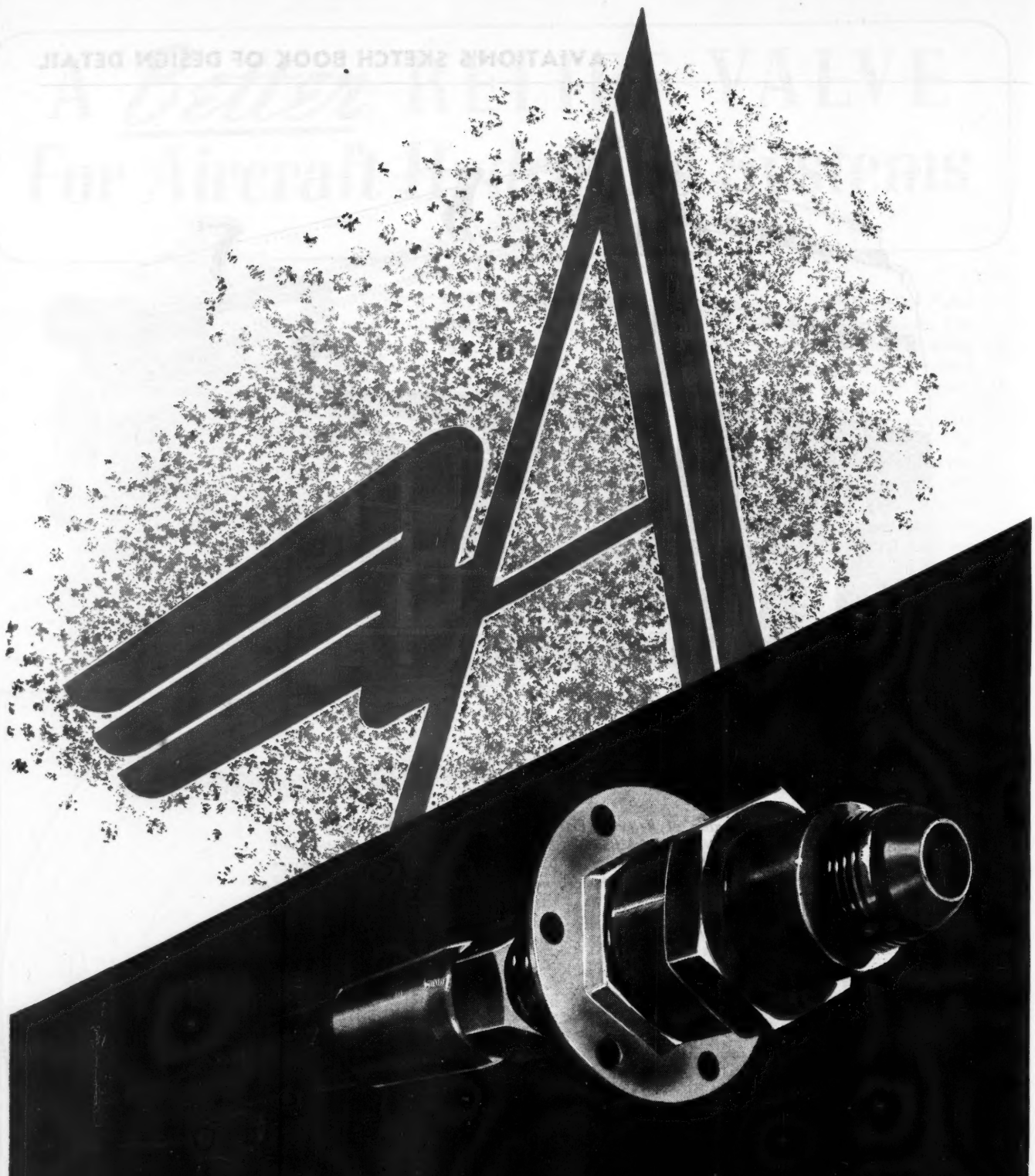
VICKERS *Aircraft*
Balanced Piston
RELIEF VALVE



Underside view of Republic P-47 Thunderbolt wing with portion of skin removed showing construction of ribs A beneath space for ammunition belts aft of spar No. 1, which is at B. Aft of stringers C ribs are conventional construction, with lightening holes, as at D. Aileron hinges are at E.



Aileron control on Republic P-47 Thunderbolt includes push-pull rod A, with directional change accomplished by idler unit B. Control unit C attaches to aileron near center aileron hinge D. Push-pull rod is installed aft of spar No. 2, E and spar No. 3, F.



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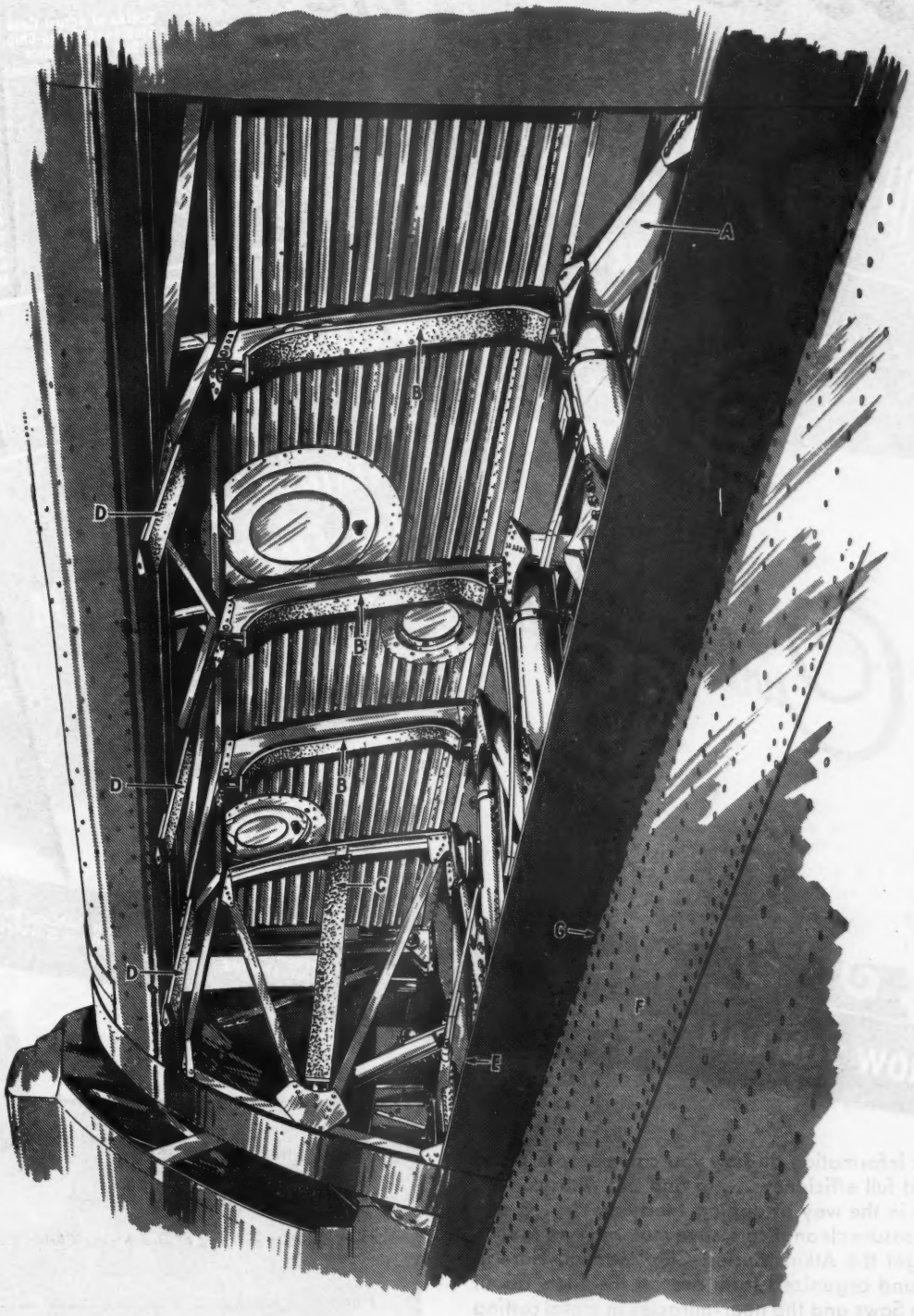
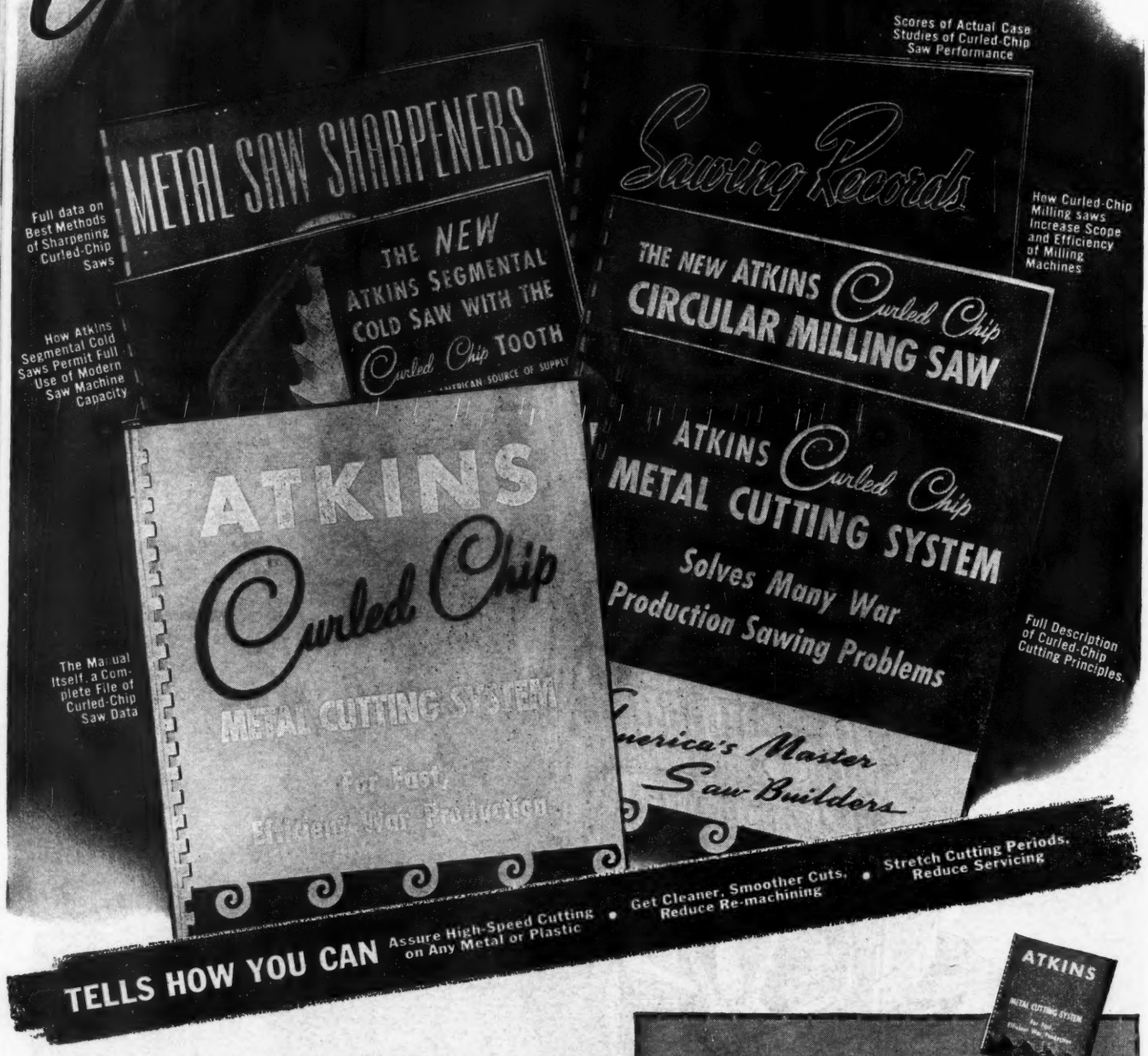


Oil tank in Boeing B-17 Flying Fortress is installed in wing forward of front spar A, fitting under ribs B—which have been reinforced to make up for section cut out for tank—with end resting against padded support on rib C. Tank is held in place by straps D, which fold under tank. Cover plate, removed in this view from below, hinges at E. In this view cover plate F for gas tank aft of front spar is swung down, hinging at G.

Yours! THIS ARRAY OF HELPFUL FACTS ON HIGH-SPEED SAWING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Sawing Records
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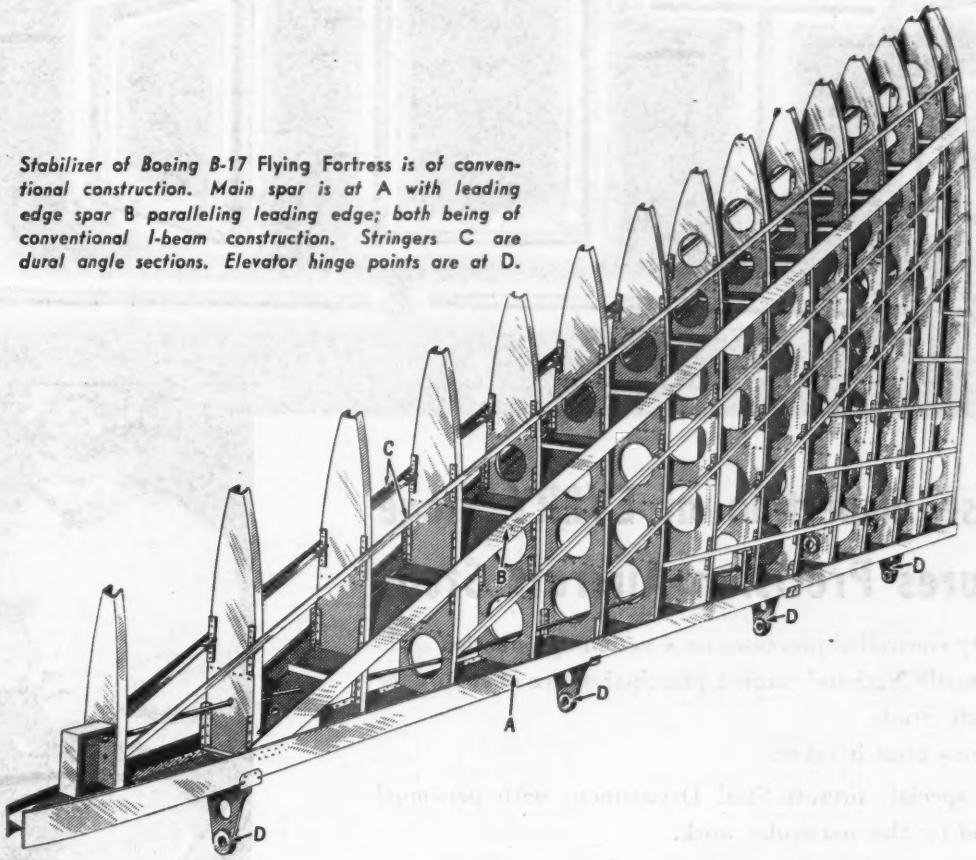
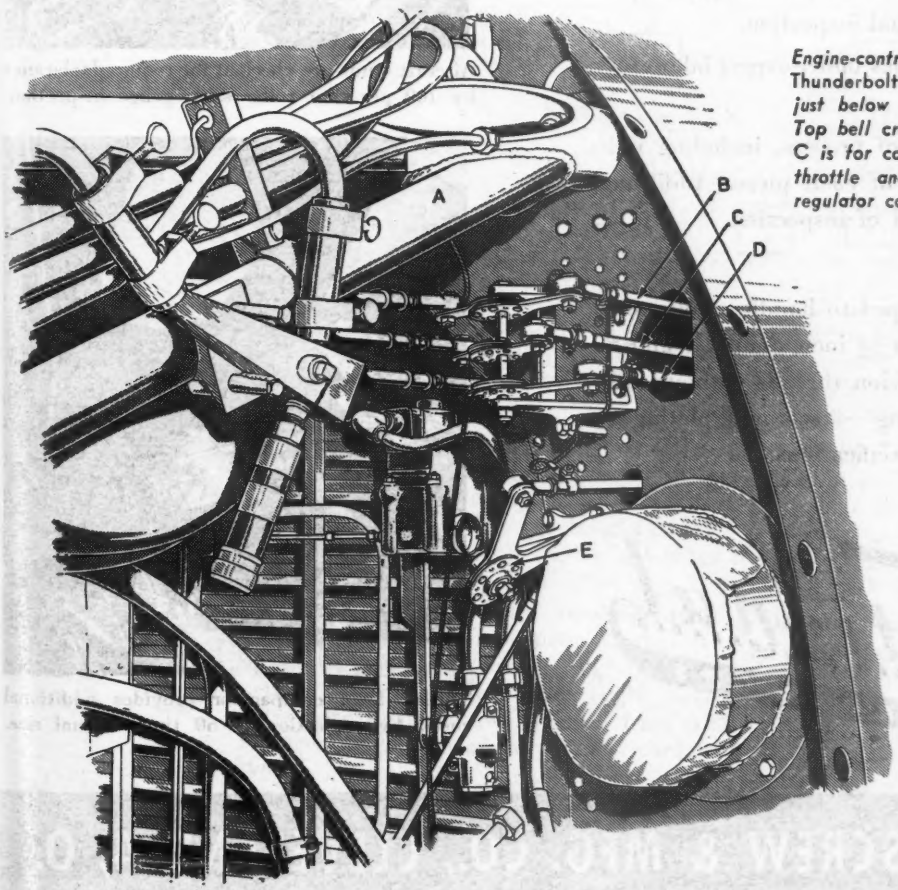
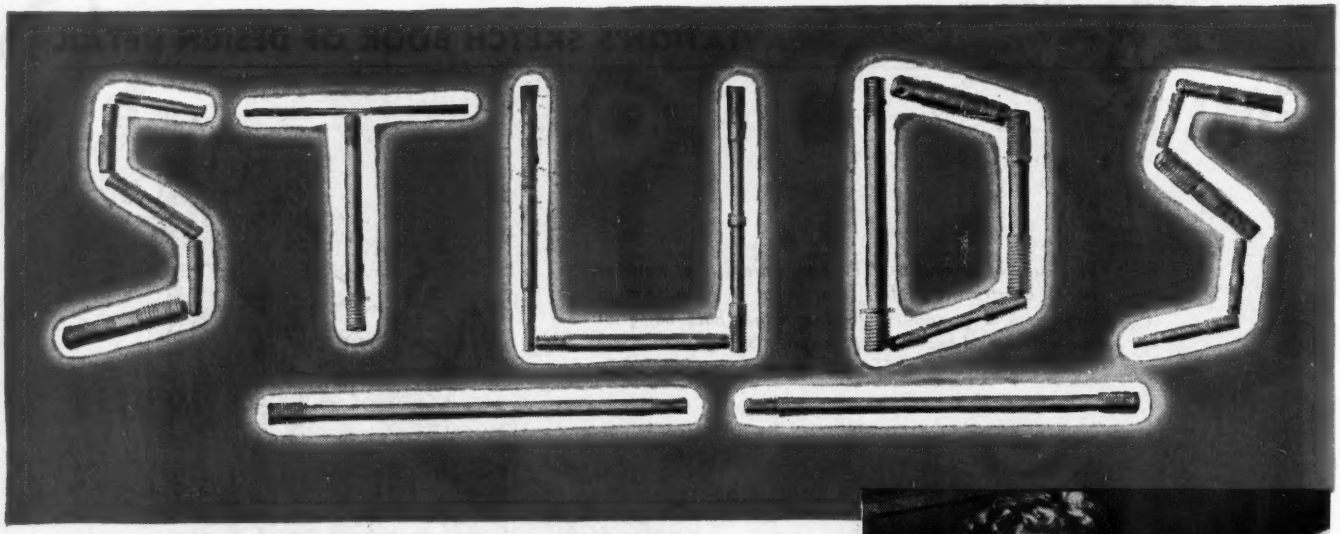
Stabilizer of Boeing B-17 Flying Fortress is of conventional construction. Main spar is at A with leading edge spar B paralleling leading edge; both being of conventional I-beam construction. Stringers C are dural angle sections. Elevator hinge points are at D.



Engine-control bell cranks on Republic P-47 Thunderbolt are located on left side of craft just below top portion of engine mount A. Top bell crank B is part of propeller control; C is for carburetor mixture control; D is for throttle and E forms part of supercharger regulator control.





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Here's what it takes:

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We are equipped to handle a full range of sizes up to ½ inch diameter and to produce precision threads without milling or grinding—steels and plating to meet AN specifications.

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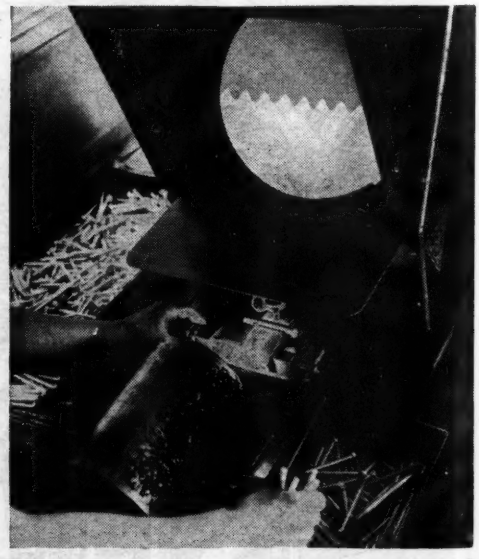
Aircraft studs are checked for required tolerance by 100 per cent roller snap gauge inspection.



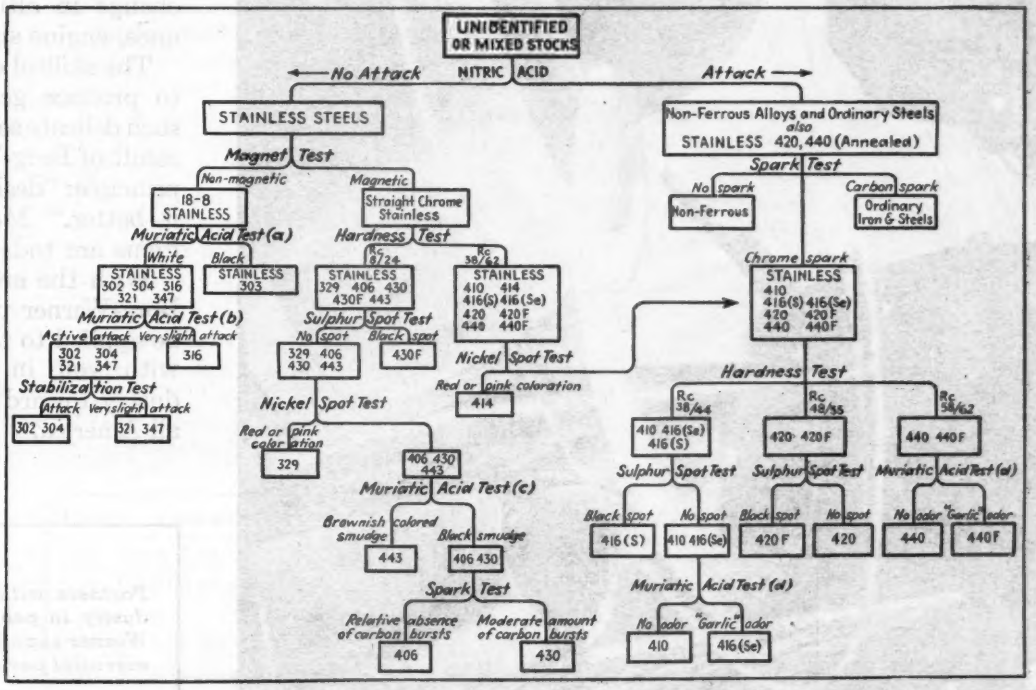
Thread form comparator provides additional check by projection to 50 times actual size.

THE NATIONAL SCREW & MFG. CO., CLEVELAND 4, O.

SHEET NUMBER D-22
CLASSIFICATION . . . . . Materials
SUBCLASSIFICATION . . . . . Stainless Steels

Identification of Stainless Steels

THIS METHOD of identifying stainless steels is useful in separating various types that show marked differences in their chemical and physical properties. It is assumed that operator making tests will have some technical knowledge of alloys in question. A comparison with known standards is recommended. These tests are not intended to take place of a chemical analysis. If, for any reason, definite information must be known of alloys present in a piece of steel, safest way is to make a chemical analysis.



In preparation of samples, all specimens must be free from scale, which may be removed by pickling or grinding. In making a spot test, always grind a fresh area before applying the solution.

Nitric Acid Test—This testing solution is made by mixing 1 part of concentrated nitric acid and 1 part of water. A drop of the solution is placed on a freshly ground spot on the specimen. Attack is denoted by a boiling action or gas evolution from drop.

Magnet Test—Austenitic Stainless Steels (18-8 types) are non-magnetic in the annealed condition but become slightly magnetic when cold-worked. This slight magnetism can easily be distinguished from the stronger magnetism of the straight chrome types.

Spark Test—A spark test is made to separate Stainless Types 420 and 440 from non-ferrous alloys and ordinary iron and steel, since nitric acid under certain conditions may attack annealed specimens of some Stainless types. These steels are identified by the characteristic short "chrome" spark.

Hardness Test —Specimens are heated to 1,850° F. and oil quenched. Various carbon percentage ranges will be noted by different hardnesses as quenched. The non-hardening types will show low hardness as oil quenched from 1,850° F.

Muriatic Acid Tests Specimens are placed in a solution of muriatic acid (1 part water, 1 part Muriatic Acid) at a temperature of 180°/190° F. A fresh solution should be used for each of the following tests:

a. After a 5 min. immersion, Type 303 will be coated with a heavy black smudge.
b. Within 2 min. after immersion, Type 316 can be identified by the very slight acid attack

Data supplied by Carpenter Steel Co., Reading, Pa.

Helping the warbirds take a big bite—

Born of combat experience, the Navy's new Curtiss *Helldiver* is heir to all the improvements developed from battle crowded skies since Pearl Harbor. And one of the things that makes it a plane to write home about is its variable pitch propeller.

The intricate gear mechanism for these 3-bladed, full-feathering props is being built by the Detroit Gear Plant of Borg-Warner's Norge Division.

These propellers adjust to every change in altitude, wind resistance, engine speed.

The skillful engineering needed to produce gear mechanisms of such delicate sensitivity is another result of Borg-Warner's long-time principle: "design it better—make it better." More than 100 war items are today benefiting by it.

With the end of the war, this Borg-Warner principle will again be applied to the task of working with you in the aviation industry toward a better living for all America.

Partners with the Aviation industry in peace and war, Borg-Warner supplies these and other essential parts . . .

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Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war: BORG & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • DETROIT VAPOR STOVE • INGERSOLL STEEL & DISC • LONG MANUFACTURING • MARBON • MARVEL-SCHEBLER CARBURETER • McCULLOCH ENGINEERING • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE • NORGE MACHINE PRODUCTS • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR

as compared with the active attack and evolution of gas on Types 302, 304, 321, and 347.

c. Immerse specimens for at least 15 min. Type 443 can be identified by a brownish colored smudge.

d. Immerse specimens in a separate container for 5 min., then remove them from the solution. A pungent garlic-like odor will be detected on Types 416 (Se) and 440F. This characteristic odor of hydrogen selenide gas will not be present in pickling Types 410 and 440.

Sulphur Spot Test—Three drops of sulphuric acid solution (1 part Sulphuric Acid, 3 parts water) are placed on a newly-ground spot on the specimen and allowed to react for 1 min. One drop of a 5% solution of lead acetate in water is then added to the acid drop and allowed to react for 15 sec. The spot is then washed with water and examined. A positive test for sulphur (Stainless Types 416 (S), 420F, and 430 F) is the presence of a black sulphide deposit.

Nickel Spot Test—Three solutions are required for this test:

Solution No. 1. Mix 125 cc. of water, 100 cc. concentrated nitric acid and 25 cc. of 85% phosphoric acid; Solution No. 2. One part water and 1 part muriatic acid; Solution No. 3. Dissolve 1 gram of dimethylglyoxime in 60 cc. of glacial acetic acid. To this solution add another solution, prepared by dissolving 10 grams of ammonium acetate in 30 cc. of ammonium hydroxide.

Procedure: Place one drop of solution No. 1 on a newly-ground spot on the specimen. Allow it to react for 30 sec. and then add one drop of Solution No. 2. This mixture is allowed to react for an additional 30 sec. and is then absorbed with white blotting or filter paper. One drop of Solution No. 3 is then placed on the moist spot of the paper. The formation of a red or pink coloration in the spot denotes the presence of nickel.

Stabilization Test—Test specimens are heated to 1,250° F. for 2 hr., furnace cooled to 800° F., then cooled to room temperature in air. The specimens are then placed in a cold solution of 3 parts nitric acid, 1 part hydrofluoric acid, and 6 parts water and left for 1 hr. Remove specimens from solution and wash with water. Stainless Types 321 and 347 will show a very slight attack from the acid. Stainless Types 302 and 304 will have rough, granular surfaces.

Type	Carbon	Chromium	Nickel	Other Elements	Brand Name
302	Over 0.08/0.20	17.00/19.00	8.00/10.00	Mn 2.00 max.	Stainless Steel No. 4
303	0.20 max.	17.00/19.00	8.00/10.00	Mn 2.00 max.; S or Se 0.07 min.; Mo. 0.60 max.	Stainless Steel No. 8
304	0.08 max.	18.00/20.00	8.00/10.00	Mn 2.00 max.	Stainless Steel No. 4-A
316	0.10 max.	16.00/18.00	10.00/14.00	Mn 2.00 max.; Mo 1.75/2.50	Stainless Steel No. 4-Mo
321	0.10 max.	17.00/19.00	8.00/11.00	Mn 2.00 max.; Ti 4 x carbon min.	Stainless Steel No. 4-Ti
329	0.20 max.	23.00/28.00	2.50/ 5.00	Mo 1.00/2.00	Stainless Steel No. 7-Mo
347	0.10 max.	17.00/19.00	9.00/12.00	Mn 2.00 max.; Cb 8 x carbon min.	Stainless Steel No. 4-Cb
406	0.15 max.	12.00/14.00		Aluminum 3.50/4.50	Stainless Steel No. 1-JR
410	0.15 max.	11.50/13.50			Stainless Steel No. 1
414	0.15 max.	11.50/13.50	2.50 max.		Stainless Steel No. N-1
416	0.15 max.	12.00/14.00		S or Se 0.07 min.; Mo. 0.60 max.	Stainless Steel No. 5
420	Over 0.15	12.00/14.00			Stainless Steel No. 2
420F	Over 0.15	12.00/14.00		S or Se 0.07 min.; Mo 0.60 max.	Stainless Steel No. 2-FM
430	0.12 max.	14.00/18.00			Stainless Steel No. 6
430F	0.12 max.	14.00/18.00		S or Se 0.07 min.; Mo 0.60 max.	Stainless Steel No. 6-FM
440	Over 0.12	16.00/18.00			Stainless Steel No. 2-B
440F	Over 0.12	16.00/18.00		S or Se 0.07 min.; Mo 0.60 max.	Stainless Steel No. 2-B-FM
443	0.20 max.	18.00/23.00		Cu 0.90/1.25	Stainless Steel No. 3

Review of Patents

By A. HARRY CROWELL, *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St. New York City (18). Printed copies of any of patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

New Seaplane Design calls for adjustable sections or steps on bottom of hull to control performance of plane on water. Steps are controlled manually or automatically, incident to aileron operation to effect hydrodynamic reactions augmenting aerodynamic reactions effected by ailerons and other flight controls.—2,348,841, filed May 14, 1941, patented May 2, 1944, J. F. Parker.

Fluid Pressure Control System automatically activates landing gear retracting mechanism when parking brake control mechanism of fluid-pressure-actuated braking system is operated during flight. A coordinated control system is provided so pilot can operate landing gear by brake control elements.—2,347,847, filed Jan. 14, 1942, patented May 2, 1944, S. Schnell, assignor to Wagner Electric Corp.

Bomb Rack Mechanism provides for successive release of bombs from plurality of stations in progressive order. Each rack station has a release mechanism which may be cocked, uncocked, and tripped by a common means.—2,347,896, filed Oct. 18, 1939, patented May 2, 1944, L. J. Eyler and C. C. Pearson.

Projectile for use against aircraft and chute troops carries several metal cables wound thereon. One end of each cable is secured to projectile; other end carries a weight. Rotating motion of projectile plus burning of rocket charges in hollow cables (also providing tracer effect) cause cables to unwind to foul targets fired upon. Means which releases weights from projectile body also serves to ignite rocket powder in cables when projectile has reached desired range.—2,347,994, filed Sept. 24, 1941, patented May 2, 1944, A. J. De Camp.

Gage for Propeller Pitch permits accurate determination of pitch angle without dismounting propeller, regardless of angle at which fuselage and engine are positioned. Gage is self-clamping on blade, leaving mechanic's hands free to make adjustments and record data obtained.—2,348,095, filed Mar. 30, 1942, patented May 2, 1944, H. H. Roby, assignor to Roby, Inc.

High Altitude Mask for use with demand-oxygen supply mechanism is constructed to protect exhaling valve from freezing or restriction of air passageways. Marginal contour arrangement engages face of wearer on each side and under chin to provide breathing chamber completely sealed from outside air. Oxygen and air are supplied from any suitable apparatus. Exhaling passageways have double walls spaced to provide insulating dead air space. Chamber into which exhaling valve opens is kept warm by exhalation gases and transfers heat to inhalation gases, which are normally cold.—2,348,108, filed Sept. 22, 1941, patented May 2, 1944, A. H. Bulbulian.

Cluster Bomb. Upon release, this multi-bomb discharges several peripheral bomb units, thus forming wide-range pattern for straddling objectives.—2,348,240, filed Dec. 11, 1941, patented May 9, 1944, A. N. Braun.

(*Turn to page* 285)

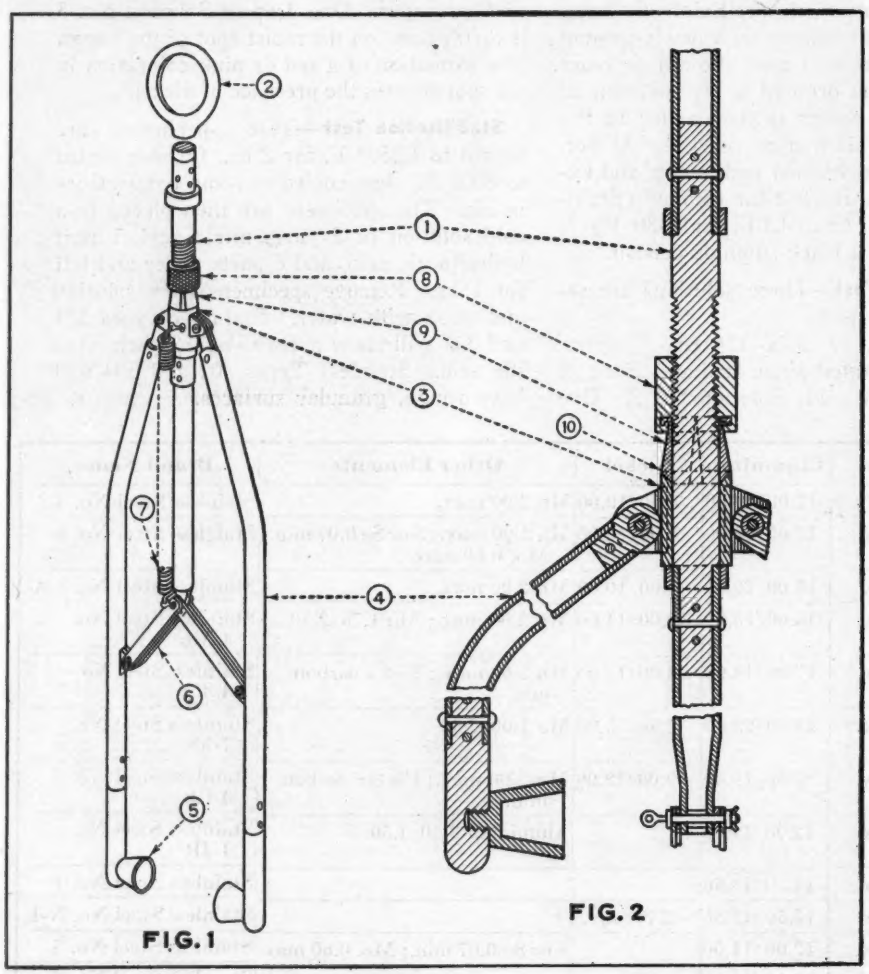


FIG. 1

FIG. 2

New Aircraft Towing Unit provides leverage to manipulate steerable wheel while moving plane. Fig. 1 shows perspective view of tow unit and Fig. 2 depicts details in section. Draft bar (1) carries tow ring (2) and slide block (3) to which are connected pivoted arms (4) fitted with axle-engaging cup members (5). Arms are also connected to draft bar by pivoted links (6). Spring (7) connects slide block to draft bar at pivoted links. Movement of slide block towards tow ring on draft bar is limited by knurled nut (8) which has integral slit conical sleeve (9) adapted to fit in seat (10) of slide block. Tow unit is attached by grasping ring and pulling one arm outwardly, causing slide block to move along draft bar toward ring. Links will tend to straighten, spreading arms so cup members are farther apart than ends of axle of steerable wheel, thus permitting attachment of tow unit. Knurled nut is threaded down to cause integral conical sleeve to fit firmly against seat in slide block. Arms are thus prevented from spreading and tow unit is held in firm connection with steerable wheel of plane. Pin members may be substituted for cup members for use with tubular hollow type axle.—2,348,741, filed Feb. 12, 1943, patented May 16, 1944, Le Roy S. Jessen.

Book Reviews

BASIC AIRPLANE MECHANICS, by H. G. Lesley. John Wiley & Sons, Inc., N. Y. 404 pages, illustrations, index. $2.50.

Deals with airplane construction, also operation, providing directions for repair and maintenance of plane components. Material analysis, routine procedures, and precautions come in for special treatment.

THE BRITISH NAVY'S AIR ARM, by Owen Rutter. Penguin Books, N. Y. 248 pages, maps, photographs. 25c.

A definitive picture of the British Fleet's powerful air arm. Over 100 photographs illustrate a rapidly moving story of the intricate workings of the vast and many-sided machine which went into operation at its highest pitch of efficiency in the June 6th invasion of Europe. Coverage is accorded to every role of the naval plane working in conjunction with water-going boats. The book is an "official story", bearing the imprimatur of the British government.

BOMBERS, by Keith Ayling. Thomas Y. Crowell Co., N. Y. 194 pages, photographs, index. $2.50.

The story of the bombing airplane from its beginning in 1912 through to Feb., 1944. Role of the bomber in this war is also considered in its relations to other types of aerial fighting craft. Included are glimpses into Russian air force details and the bomber strength of Japan.

AIR ACROBATICS ARE EASY, by D. J. Brimm, Jr., M. A. McGraw-Hill Book Co., N. Y. Two sections: both of 133 pages, charts; and flat carton containing a three-dimensional stereoviewer with interchangeable color plates. $2.50.

Brimm's book and accompanying demonstrative paraphernalia comprise a novel approach to the problems of giving student pilots a graphic picture of aerial acrobatics from the viewpoint of the cockpit itself. The handbook lists and explains the many types of aerobatics, delineating their origins and procedures, while the stereoviewer "theater" enables the student to observe them in action, providing visual simulation of the earth as seen from a plane's cockpit at several thousand feet.

(*Turn to page* 286)

Geared for Flight!

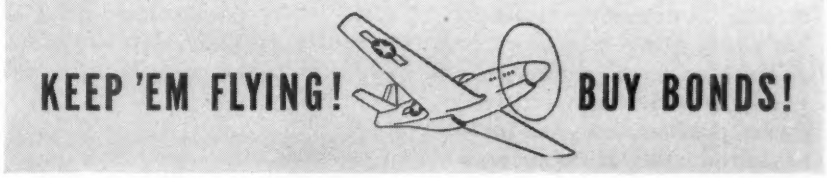
HERE is the heart of an Aeroprop. Here are the simple components that produce the unvarying "on speed" Aeroprop performance that adds efficiency to the power and flight of many fighting airplanes.*

The Aeroprop's speed and precision of pitch control is achieved with unique simplicity. The entire assembly is self-contained and self-operated—unhampered by power lines or other accessories. Responding to powerful hydraulic pressures the blades may vary from low pitch to full feather in five seconds. Neither altitude nor temperature affect their swift automatic movement to the precise degree of pitch that produces top performance.

Equally important is the Aeroprop blade design incorporating hollow, rib-reinforced, steel construction of exceptional strength and lightness—plus the overall simplicity that makes it possible for one man to install an Aeroprop in as little as 12 minutes.

Today Aeroprops have been assigned to service on two of the most formidable fighters in the Army Air Forces. Their amazing performance on these advanced ships is a guarantee of their high contribution to the conquest of the skies.

*P-39 AIRACOBRA • P-51 MUSTANG



Aeroprop

ARMY-E-NAVY

In War and Peace, Propeller Production at its Best!

AEROPRODUCTS DIVISION • GENERAL MOTORS CORPORATION • DAYTON, OHIO

GM ARMS FOR VICTORY

The Greatest American Legend...

He's a man without a last name . . . a fellow known to every American kid as "Uncle." He is everywhere in his great land—yet no one has ever seen him. He is the great spirit of America . . . calm, quiet, peaceful and kindly until he gets his "dander" up—then he is determined, strong and his wrath is relentless.

His is the spirit of sacrifice, toil and patriotism. He has weathered many wars, trials and tribulations—yet he is indomitable. He stood with Washington at Valley Forge . . . Perry at Lake Erie . . . Lincoln at Gettysburg . . . Pershing at the Marne . . . MacArthur at Bataan. He stands with every American to defend America.

Today, he stands with you . . . urging you to do more and more in the cause of Victory. To buy more War Bonds—to contribute to the blood bank—to stamp out Black Markets—to defeat inflation—to be untiring in your efforts to hasten the day when our enemies will fall before our might. Ask yourself squarely if you couldn't be doing *more* to aid this great spirit—then *do* it.

Let's keep this *greatest* American legend . . . *GREAT!*

APEX

THE APEX MACHINE AND TOOL COMPANY • DAYTON 2, OHIO

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

20th Air Force Formed; New Global Bomber Fleet Ranged to Strike Anywhere in the World

Light planes' war record keys postwar designs . . . CAA's design for use . . . Airport bill . . . Aviation ROTC urged . . . PAAC appointments . . . Postwar transports visualized . . . SAE and IAS meetings CAA outlines international routes

Creation of an entirely new AAF organization—the formidable 20th Air Force—was announced coincident with the initial bombing of Japan by Boeing B-29 "Superfortresses."

Operating on the bomber command plan, the 20th employs B-29's as a powerful air task force primed to strike anywhere in the world. Headed by Gen. H. H. Arnold, it is under joint chiefs of staff of all U. S. military forces.

As a global, rather than territorial, war arm, this separate aerial battle fleet is being directed flexibly through centralized control at Washington.

Thus, through our industry's development of the super-range bomber, military aviation has entered a potent new global air war phase. Further, the launching of the 20th in the Far East last November, its activation on delivery of B-29's early this year, and its present action against the Japanese prove our industry's ability to put victory-winning air power on both sides of the world at once.

Light Planes' War Record Keys Postwar Designs

When the full story on performance of light (liaison) planes in this war is available, it will add much to present knowledge of design and use of private planes in future. Endurance of the little observers despite constant beating, ability to operate with but limited maintenance, capability in bad weather, and performance on restricted ground areas has surprised even the engineers who produced them.

Of the dozen or so light plane makers, all producing for the war various aviation products, most are finding time to work on their postwar programs. Experimentally, they are engineering or flying practically every reasonable design idea of the past and present. Pushers, single seaters, family sedans, two controllers, non-spinners, flying cars, roadable planes, autogiros, and helicopters—all are being tried.

Designers think they are doing pretty well improving utility and safety, and they are less concerned with speed for amateur flying than they used to be. What bothers them most is price. Very few if any producers believe they can turn out a "minimum" two-place plane during early postwar period for much less than $1,500. Still more frequently mentioned tag is $2,000. Those working on four-place designs admit they will have a very hard time getting down anywhere near the $2,000 mark.

Volume production is the only thing that can help the price problem. To get volume production, producers will tend strongly to eliminate choice of two or three engines and various equipment. Some producers will offer a minimum plane (which the purchaser can add to out of dealers' stocks if he wishes) and a de luxe model with every desirable gadget attached.

CAA's "Design for Use"

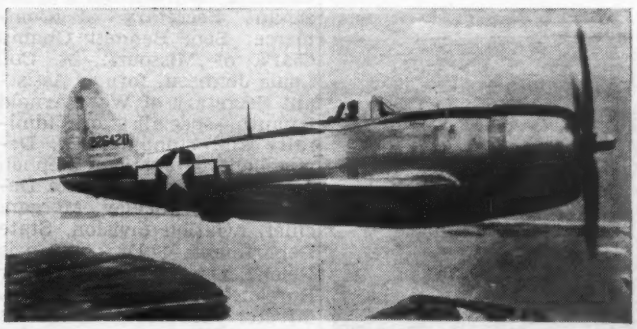
To facilitate postwar production of light planes, the CAA proposes to authorize the design of planes according to their intended use. For instance, a family plane does not need the same stress characteristics as does an acrobatic type; the weight saved can be given over to fuel. Design categories suggested by CAA are: Acrobatic, training, general purpose, transport, and special purpose.

Airport Bill; JAV Meeting; Wichita Plans

General opinion is that a well-planned small airport program can help private aviation more than anything else. Charles I. Stanton, CAA administrator, is actively promoting a bill in Congress to provide about 3,000 more airports in addition to the 3,000 already established in this country. Stanton proposes that the States match federal funds for construction of fields, following the plan under which the federal highways system was developed (also see item "Federal-State Airfield Plan" in Transport News).

A large proportion of the fields would be Class Fours, for light planes. It is expected that some small fields will be built with private funds. National Aeronautic Association has called for a Joint Airport Users' Conference (July 24-25, Hotel Statler, Washington, D. C.) to assist in planning the program.

Wichita, Kan., may have a series of airparks within walking distance of business and residential areas, if aviation



MORE-POWER-PLUS "THUNDERBOLT"

New Republic P-47 "Thunderbolt" fighter-bomber, with greater power and range of action, and stated to carry heaviest bomb load of any single-engine fighter, is now in combat in European and Pacific theaters. Powered with turbosupercharged, 2,000-plus-hp., 18-cyl. P. & W "Double Wasp" engine, it has larger water injection capacity which adds several hundred extra hp. and doubles time of peak emergency power use. States company: "Paddle-blade" propeller increases climbing speed 400 ft. per min. Plane can do better than 400 mph., exceeds 700 mph. in power dive, and with 50 percent more oxygen capacity has longer operation at altitudes up to more than 7 mi. Added internal fuel capacity gives longer range, which can be extended when auxiliary tanks are substituted for 1,000-lb. bomb under each wing. New "bubble" canopy affords "round-the-clock" visibility, and new gunsight provides improved sighting for eight 50-cal. wing guns.

Coming Up

July 17-18: Air Traffic Conference, Denver.

July 24-25: National Aeronautic Association Joint Airport Users' Conference, Hotel Statler, Washington, D. C.

July 27-28: Summer Meeting, Institute of Aeronautical Sciences, Los Angeles.

August 1-2: Eastern Division Meeting, Airworthiness Requirements Committee, New York; Western Division Meeting, Los Angeles.

August 2-3: National Aeronautic Association Business Meeting, Denver.

September 4-6: Annual Meeting, Aero Medical Association, Hotel Jefferson, St. Louis.

September 22: Air Transport Meeting, Institute of Aeronautical Sciences, Hotel Statler, Washington.

October 5-7: Society of Automotive Engineers National Aircraft Engineering & Production Meeting, Engineering Display, Hotel Biltmore, Los Angeles.

November: 9-10: Fall Meeting, Institute of Aeronautical Sciences, Dayton.

November 15-18: Second annual Clinic of Domestic Aviation Planning, Oklahoma City.

December 4-6: Society of Automotive Engineers National Air Cargo Meeting, Hotel Knickerbocker, Chicago.

December 17: Wright Brothers Lecture, Institute of Aeronautical Sciences, Washington.

January: Thirteenth Annual Meeting, Institute of Aeronautical Sciences, New York.

January 8-12: Society of Automotive Engineers Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit.

leaders have their way. It is expected that many other cities will develop similar plans.

Urges Aviation ROTC

To provide 50,000 pilots per year for postwar air power, National Aviation Trades Association (training contractors) proposes an over-all air reserve ROTC, covering basic military flight requirements with the civil training program. NATA believes that training should be given in colleges and high schools, thus producing minimum interruption in the student's life. Permanent airports located at the schools would be available for military use in case of war. Outstanding students would receive scholarships.

Postwar Craft Visualized At C-W Forum

Preparations for the future received consideration at the Curtiss - Wright Production Engineering Forum held recently in St. Louis. How the airlines are working toward "tailor-made" aircraft to meet the various needs of postwar air commerce are described by W. W. Davies, superintendent of research, United Air Lines, Chicago, in his paper, "Some Thoughts on Design for Airline Operation."

Transport operators, said Davies, formerly took planes which were available and adapted them to their needs, but henceforward the airlines would work closely with the manufacturers to attain the best product. He specifically mentioned the airlines' interest in cabin and cockpit design. Davies described various types of planes as "rough guesses" of what he believes may be seen on the airways within five or six years after the war. Descriptions follow:

1. Ocean transport: 125,000-150,000 lb. gross wt.; day capacity 80-90 passengers, night sleep 50-60; reasonable cargo space; speed 225-250 mph.; operating altitude 10,000-25,000 ft.

2. Domestic de luxe sleeper and day plane: 70,000-80,000 lb. gross wt.; day capacity 60-65; night sleep 30-35; moderate cargo space; speed 275-300 mph.; operating altitude 10,000-20,000 ft.; range 700-1,000 mi.

3. Domestic standard sleeper and day plane (if above plane required "extra fare" for speed): 50,000-60,000 lb. gross wt.; day capacity 50-60, night sleep 25-30; speed 250-275 mph.; operating altitude 10,000-20,000 ft.; average trip lengths 400-750 mi. (Also straight day version of this plane, carrying 60-70 passengers, particularly if costs could be lowered to attract general public.)

4. Trunk-line feeder plane: 30,000-35,000 lb. gross wt.; capacity 30-35 passengers or 9,000-10,000 lb. cargo, or combination of both through use of movable bulkhead adjustable at station stops; speed 200-225 mph.; operating altitude 4,000-12,000 ft.; average range 150-300 mi.

5. Domestic off-line feeder plane (essentially same design as trunk-line feeder craft but smaller): 15,000-20,000 lb. gross wt.; capacity passenger craft 12-18; speed 200 mph.; average trip lengths 50-200 mi.

6. Full cargo plane: Ship probably featuring general characteristics of trunk-line feeder, to carry "slower" cargo as differentiated from high speed cargo which would be accommodated in shipping space of passenger planes.

Engine Papers Before SAE

Two papers featured at the National War Material Meeting of the SAE, held recently at Detroit, were "Lessons From Aircraft Engines Applied to Heavy Duty Ground Vehicle Engines," by Vincent C. Young, chief engineer, Wilcox-Rich Div., Eaton Mfg. Co., and "Some Aircraft Engine Production Methods," by Martin M. Holben, project engineer, Wright Aeronautical Corp.

Auxiliaries IAS Topic

Recent meeting of the Institute of the Aeronautical Sciences in New York City featured a comprehensive talk on design, production, and installation of auxiliary engines in aircraft by Dr. Rowland Burnstan, president, Lawrence Aeronautic Corp. Also a short, revealing film was exhibited by Jerome Lederer, of Aero Insurance Underwriters. The latter showed the running "dial story" of the instruments in a training plane during the test flight in which the ship lost its port wing and crashed, killing the pilot.

PAAC Appointments

New members for the U. S. National Commission of the Permanent American Aeronautical Commission are announced by the State Department, terms of members named to the first commission (Sept. 1941) having expired. Named are: Oswald Ryan, CAB member, chairman; Rep. Alfred L. Bulwinkle, of North Carolina; William Burden, Assistant Secretary of Commerce; Sen. Bennett Champ Clark, of Missouri; Lt. Col. Louis Johnson, former Assistant Secretary of War; Arnold Knauth, specialist on admiralty and shipping law, Department of Justice; Stephen Latchford, air law, State Department; Stokeley Morgan, chief, aviation division, State Department; Dr. Francis Reichelderfer, chief, Weather Bureau; and T. P. Wright, director Aircraft Resources Control, APB.

International Routes Outlined by CAA

CAA's basic route pattern for international air commerce operations, as revealed by Chairman Pogue, provides for about 50 routes which would expand the 80,000 mi. already approved for overseas transport to make a total of 140,000 mi. under U. S. operation (see map and list of routes in article "Three International Policies," page 190).

Flow of traffic was the criterion in drafting the routes. Any consideration of specific carriers must await individual check of the applications filed with the CAB by some 100 carriers. Absence of clarification of U. S. policy brought formulation of the plans under the present law, interpreted by CAB as calling for competitive private operation on some foreign routes (such as across the Atlantic).

The board emphasized that many routes could not be operated without agreements with countries involved. Acquisition of foreign landing rights, expected to be by inter-governmental negotiations, would be a function of the State Department.

Adding to the Language

Boston—Acceptance of new aviation nomenclature received endorsement when Jos. T. Geuting, vice president of General Aircraft Corp. and chairman of the Aero Chamber's Personal Plane Committee, announced a 4-yr. personal plane landing facility expansion program.

The words are *airpark*, identified as a community center for personal flyers, costing from $10,000 up, and *fightstop*, a runway with pay phone and coin-in-slot gasoline service, built adjacent to a highway, costing from $6,000 to $10,000.

★ SPOT CHECKING ★

Sikorsky helicopters of the YR-4 type aided our forces in the airborne invasion of Burma. Men flying them are volunteer pilots especially trained at the Sikorsky factory. They arrived in India last January, have their own technicians and ground crews.

Scott Aviation Corp. is now operating a Fairchild 24 as a sales department aid to save company officials time in contacting dealers and customers.

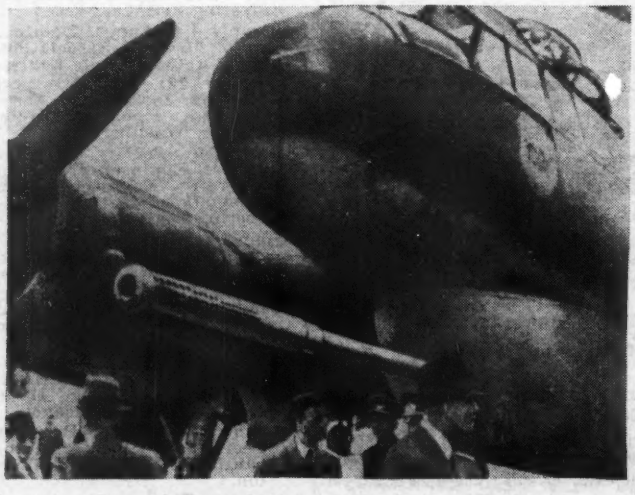
Twenty-fifth anniversary of the NC-4 flight—initial air conquest of the Atlantic in 1919—was observed in late May at a special dinner sponsored by the Aircrafters, engineering society at the Aircraft Factory, Navy Yard, Philadelphia, with societies, manufacturers, and air transport companies participating.

Douglas C-54 (DC-4) transports are now flying combat crews and high-priority airplane parts direct to New Guinea via Hawaii. Old route was by way of Australia, with transloading to C-47's for hop to New Guinea. Flown by United under contract to Pacific Wing, ATC, the planes average 41 hr. for the run, carrying from 8,000 to 11,000 lb. of cargo, or 27 passengers (including crew of 6).

"Planning the Future of Your Business," is new handbook prepared by Assn. of Consulting Engineers for Committee for Economic Development. Setting forth detailed concrete steps to attain high postwar levels of production and employment, it is available from local CED offices (they are organized in 1,408 communities).

Credit for inception of the Army-Navy production award program goes to Capt. Lewis L. Strauss, USNR, who developed idea for "E" flags (now flown by nearly 3,000 plants) following assignment from Secretary Knox in 1941.

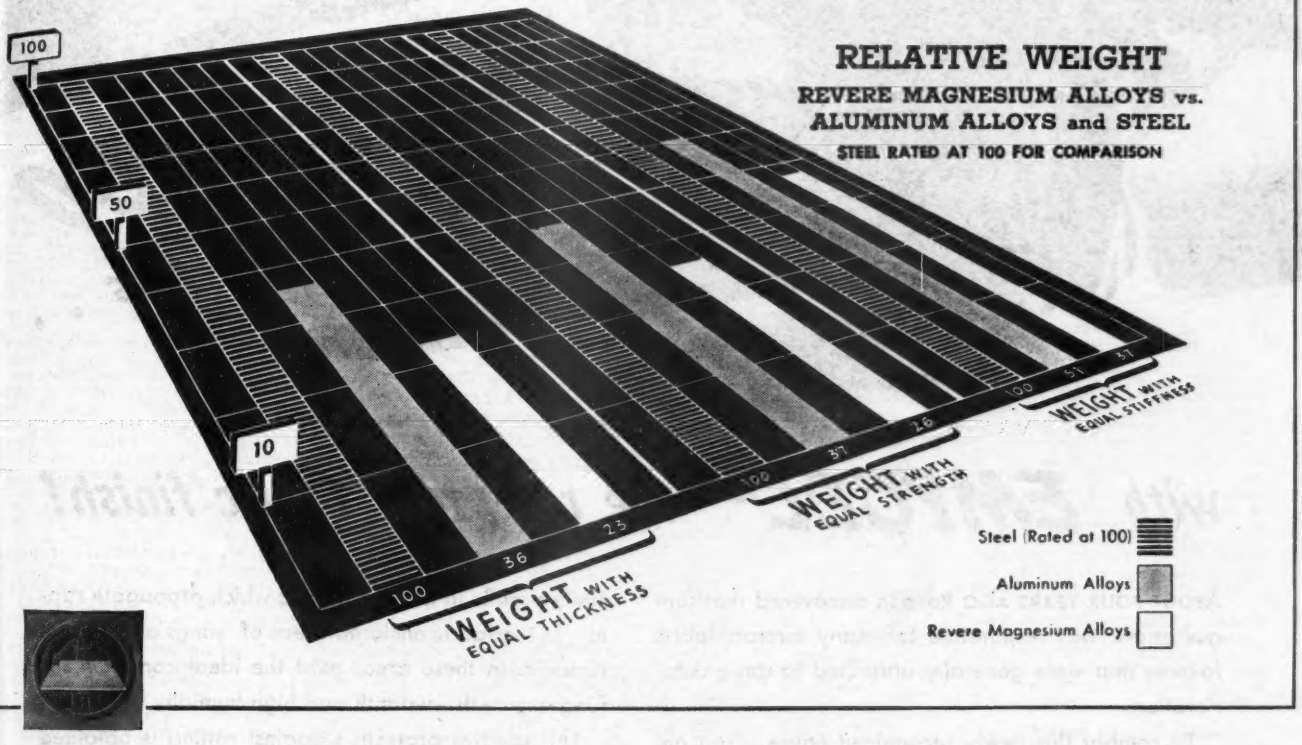
Recent forced landing of a Navy Martin "Mariner" at Willcox Dry Lake, Ariz., didn't mean the 20-ton plane had to be dismantled and shipped out. Onto her tail went a 2-ft. wide skid, then she was cradled on beaching gear—a special rig, with two sets of double-tire wheels, fitted with reinforced mounts for attachment to plane. And with this improvised landing gear she took off and completed her journey. After takeoff, pressure levers released the shackle bolts, and wheels and skid were dropped.



IMITATION IS SINCEREST FLATTERY

After struggling for many months against "Hurricanes" with two 40-mm. cannon. Germans have brought out this Junkers 88 with protruding 40-mm. quick-firing cannon in unsightly blister under nose.

NOW AVAILABLE } Magnesium Alloy Sheets by REVERE



THE world's largest magnesium sheet and plate mill is now in operation—by Revere. Here are produced the three alloys in demand for wartime uses:

Revere Magnesium "M" — Magnesium-Manganese alloy with moderate strength and good forming characteristics.

Revere Magnesium "FS-1"—magnesium-aluminum-zinc alloy, a general purpose metal combining high strength with good forming characteristics.

Revere Magnesium "J-1" — magnesium-aluminum zinc alloy, the highest strength sheet available.

When production exceeds war needs, Revere Magnesium Alloys will be available for use in an ever-increasing number of fields, such as automotive, household appliances, railroads. These alloys will bring revolutionary economies in weight, power, machining, production, labor. For technical assistance in planning conversion to these wondrously light magnesium-base metals, write Revere.

REVERE MAGNESIUM ALLOY SPECIFICATIONS

Grades and Tempers

h = hard rolled a = annealed

r = hot rolled

Alloys M, FS-1, and J-1 can be furnished in these tempers:

Revere M	Tempers h, a, r.
Revere FS-1	Tempers h, a, r.
Revere J-1	Tempers h, a, r.

The mill should be consulted regarding these tempers.

LIMITS OF MANUFACTURE

Sheets and Plates

Supplied from 0.020 inch and thicker in a wide range of sizes, depending upon the thickness and weight of the sheet or plate.

REVERE

COPPER AND BRASS INCORPORATED

MAGNESIUM-ALUMINUM DIVISION

Founded by Paul Revere in 1801

Executive Offices: 230 Park Ave., N. Y. 17, N. Y.

INDEX TO SPECIFICATIONS

Form	Revere Alloy	American Society for Testing Materials		Society of Automotive Engineers	Aeronautical Material Specifications S. A. E.	Navy Bureau of Aeronautics		Navy Department		U. S. Army Air Forces	
		Alloy Designation	Specification No.			Alloy Designation	Specification No.	Alloy Designation	Specification No.	Alloy Designation	Specification No.
Plate, Sheet and Strip	M	11	B90-41T	51	4370	..	..	11	47 M 2	1	11339
	FS-1	18X	B90-41T	..	.....	..	..	18	47 M 2	..	11340
	J-1	8X	B90-41T	..	4380**	..	..	8	47 M 2	2	11338

**4380 annealed 4381 hard rolled

with EMYCEL* — the rot-proof fabric finish!

ABOUT FOUR YEARS AGO Roxalin discovered that fungus attack was responsible for many aircraft fabric failures that were generally attributed to dope deterioration.

To combat this newly recognized cause of an old complaint, Roxalin pioneered EMYCEL, another finish *engineered for specific performance*. The derivation of the name itself indicates EMYCEL's special function —*Ex* meaning "out"—*mycellium* meaning "fungus."

Special fungicides incorporated in EMYCEL prevent fabric rotting caused by fungus spores which are especially prolific in the tropics and which propagate rapidly in the fabric enclosed areas of wings and control surfaces. In these areas exist the ideal condition for fungus growth—warmth and high humidity.

This positive protection against rotting is obtained with the first coat of EMYCEL; no extra cost or operations are involved.

Second big feature of EMYCEL is equally important. It can be sprayed on in all kinds of weather. Moisture in the air will not cause blushing. You don't have to allow for "rain checks" in your production schedule.

OTHER VITAL ADVANTAGES

EMYCEL is economical. It always reduces the number of coats required—savings up to 30%.

EMYCEL is faster. All-spray system cuts fabric finishing time by eliminating hand brushing.

EMYCEL protects fabric from injury. Super-flexibility resists impact of flying objects at sub-zero or high temperatures.

EMYCEL is C. A. A. approved and backed by three years of world-wide service on all types of aircraft.

ROXALIN *Flexible* FINISHES
INCORPORATED
ELIZABETH • NEW JERSEY

*Patented

WATCH ROXALIN IN AVIATION

Government of India seeks applicants for position of professor of aeronautical engineering at Indian Institute of Science, Bangalore, India. Statements regarding qualifications, salary, etc., can be obtained from India Supply Mission, 635 F St., NW, Washington (4), D. C.; from the Hon. William Burden, assistant Secretary of Commerce, Department of Commerce, Washington (25), D. C.; or from **Aviation.**

Oklahoma City has created an aviation commission to coordinate its aviation expansion program. Steadham Acker has been named aviation consultant, and Commission members are: Fred Jones, who was named chairman; D. Callahan, Dan James, Maj. Herbert Peck, Dr. C. Q. Smith, Roy J. Turner, and Hosea Vinyard.

Feature of shipment of aircraft from the Atlantic Overseas Air Service Command, Newark Airport, is a liquid spray which, after application to aircraft bodies, congeals in less than half an hour to form a thin plastic protective coat sealing the plane against weather and corrosion during its ocean trip. This coat, readily peeled off after arrival, resists —30 to 180+ F. temperatures. Peelings are salvaged and ground up for re-use. Planes, parts, and other equipment processed and shipped from Newark base have constituted approximately 25 percent of the total shipping out of New York harbor.

Identification has now been released by the War Department on three new combat planes. These are the A-26 "Invader," new Douglas light bomber, which is a more powerful version of the famed A-20 "Havoc"; the P-63 "Kingcobra," larger and improved version of the Bell P-39 "Airacobra"; and the P-59, "Airacomet," Bell jet craft.

National Headliners Club has awarded a bronze medallion to Aviation Writers Assn. as special recognition for consistently improved reporting on aviation.

AAF Training Command has instituted a new program to fit former AAF and WTS instructors for flying capacities in the service following discontinuance of various flight-teaching projects.

Shipbuilder Henry Kaiser is publicizing a plan for a non-profit corporation for establishment of 3,000 to 5,000 personal plane fields in the first half year after the war. Cost of the smaller number of fields is put at $150,000,000. It is stated that some 4,500,000 persons could be employed in this broad move to build a market for private aircraft. Details of financing have not precisely jelled, but the RFC might be called upon for one-third of the initial cost.

Manufacturing methods relative to aircraft and parts comprised the topic at a recent meeting of some two score Central and Eastern Aircraft Council members held at Goodyear Aircraft.

Newest and biggest cold-test chamber is in operation at AAF Materiel Command laboratories, Wright Field. With a 60,000 cu. ft. capacity, chamber measuring 25x25x80 ft. can accommodate fuselage of a B-17. Temperature can be dropped as low as —95 F. Five engines provide power for refrigeration units.

Design for interchangeability of both parts and assemblies of aircraft was primary consideration at recent four-day National Aircraft Standards Committee seventh national meeting in Los Angeles.

Air Power Spearheads Invasion

America at War
Aviation's Communique No. 31

Germany's war machine took three staggering blows in one week: (1) When the USAAF completed its over-Europe shuttle terminus in Russia; (2) when Allied forces knocked Rome out from under Nazi Italy; and (3) when—finally and most emphatically—Anglo-American invaders poured into Europe paced by the power of 11,000 planes.

Heavy tactical support of Allied troops by bombing and attack aviation still left thousands of heavies and fighters to continue strategic operations against Germany's production and communications.

Just before the invasion, the biggest air fleet ever mobilized, totaling 7,500 of the massed 11,000 planes, hammered rail stations, highways, bridges, and transport centers all along the invasion coast of Europe—a 24-hr. 9,000-ton punch of fire and explosives.

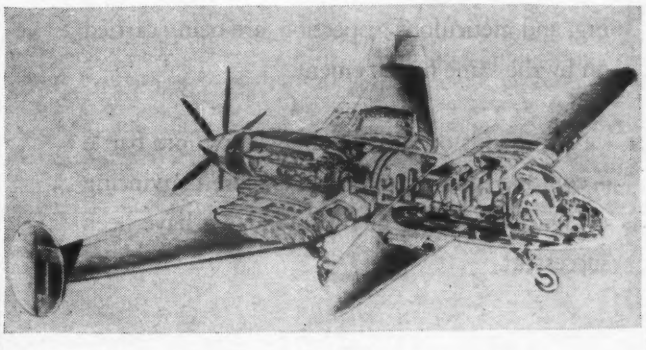
To what extent the bombing of Nazi industry and transport has weakened the German powers of resistance, and how effectively air attack can support ground forces on a big scale, will be observed conclusively as the war in Europe develops. Several Allied weapons not publicly known, some of them in aviation, are being employed.

Both parachute and glider troops dropped behind the Germans with successful results. Allied aviation and airborne troops took many airfields, and it was further demonstrated that bombing of sufficient weight can churn up runways faster than the greatest effort can return them to usability. Air bombs were put down to make shell holes for the protection of troops on exposed terrain.

The sparse initial air resistance to the Allied attack seemed to reveal that Goering has not been able to accumulate a strong fighter plane reserve to meet the assault. He had lost fighters heavily through the "birth control" attacks on his plants, and at least 1,200 by ground strafing, plus shot-down losses in the air, 50 and sometimes 100 in a day. His production rate of not more than 2,000 planes, all types, per month, cannot support such attrition.

The Luftwaffe's high command called an emergency meeting, according to a clandestine radio report, when the Russian - based AAF bomber shuttle started. Although B-17's and B-24's formerly could reach all far-eastern Nazi installations, they had to limit their bomb loads to do so. With the Russian bases, they can now hit much harder, hence the Germans will have to redistribute their fighters. Via the shuttle, B-29 striking power would also be greater.

Preparation for the shuttle involved shipment to Soviet bases of 12,000 tons of runway steel matting, 10,000 tons of gasoline, and masses of other goods. The work was started last February.



"FLYING-DUCK" FIGHTER

This new fighter, offered in both single-engine pusher type (depicted here) and as twin-engine tractor, recently made first test flights in England. Designated the Miles 35 shipboard fighter, diagram (top) indicates features, including contra-rotating prop, heavy armament, and good pilot visibility. Plane is somewhat reminiscent of Westland "Pterodactyl" of 10 yr. ago. Photo (above) shows Miles 35 trial model (about half-size, with smaller engine, and using fixed landing gear) at takeoff. Interesting points are very large bulge in tail, apparently housing coolant radiators, and extra wheel under engine to prevent damage to propeller in tail-down landings. (British Combine photo.)

★ CANADIAN NOTES ★

By James Montagnes

Noorduyn UC-64 "Norseman" single-engine transports are now being used by RCAF in removal of wounded from front lines. RCAF is also using twin-engined Douglas DC-3 "Dakotas" as ambulance transports.

Canadian Vickers, Ltd., Montreal, has a government contract for 50 Douglas DC-4 transports, powered with Rolls-Royce "Merlin" engines, for Trans-Canada Air Lines. Delivery of first craft is to be within 13 months of delivery of engineering data to company. Building DC-4's in a government-owned section of its plant, Canadian Vickers will receive 2 percent management fee. A target price has been set at $350,000 for each aircraft, and the government has right to increase or decrease the order, with reasonable adjustments in this price. Government pays all tooling costs, allowing company .1 percent increase or decrease for each $10,000 decrease or increase in the cost of aircraft.

Trans-Atlantic crossing record was set recently by a Canadian-built "Mosquito", which crossed from Labrador to Northern Ireland, a distance of 2,200 mi., in 6 hr. 46 min.

Rehabilitation of Canadian veteran airmen has started, with first five having been placed as transport pilots with Trans-Canada Air Lines.

Canadian Pacific Air Lines carried 31,833 passengers during the first four months of 1944, an increase of 75 percent over same period in 1943. Freight and express amounted to 3,159,459 lb., a decrease of 11 percent, and mail totalled 619,140 lb., a decrease of 27 percent.

By F. H. Fullerton

Despite a decrease in personnel of some 1,000 workers under peak figures of '43, Boeing Aircraft of Vancouver, B. C., has increased its production efficiency and achieved a steady rise in schedules—for production methods have been streamlined via re-tooling and re-jigging, and marked decreases in man-hours on certain jobs have been recorded. Bulk of personnel reduction came during past three months through natural labor shrinkage, terminations, army call-ups, and a weeding process, bringing current personnel to just under 9,000.

Production of deck plates for Consolidated PBY hulls will be undertaken in Boeing's Chilliwack, B. C., plant, which to date has confined its work to wing assemblies.

American Screw Products

OF LOS ANGELES

Announces Its New Name

THE DEUTSCH COMPANY

This change was found desirable because of confusion arising from similarity of the former name with that of other companies.

The policies and traditions established by American Screw Products – progressive designing, careful engineering, precision manufacturing, and meticulous inspection, are being carried on by the same management.

Thousands of Allied planes flown into battle – equipped with our products – are convincing evidence that these quality standards have been successful.

THE DEUTSCH COMPANY

Manufacturers of Hydraulic Valves and Fittings

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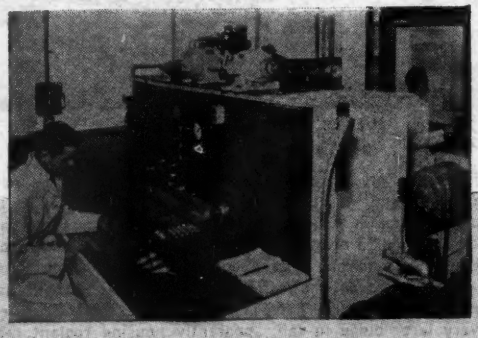

Where Research Develops Quality, Precision Products

★ CALLING NAMES ★

Capt. Trow Sebree, PCA pilot, has been appointed director of the Navy Transitional School to be conducted by PCA at Roanoke, Va.

Ward Canaday, Willys-Overland president, was awarded a certificate by United Air Lines in appreciation of his contributions to airline progress.

Pan American Airways has awarded 15-yr. pins to **Jesse M. Van Law,** special asst. to the manager of the Atlantic division, and **Albert G. Thomas,** maintenance training superintendent, both at LaGuardia Field, N. Y.

Wolfgang Langewiesche has joined Chance Vought's flight test department.

Harold G. Fitzpatrick was elected secy.-treas. of Jordanoff Aviation Corp. and **William C. Hoff** was appointed asst. technical director. Also **Helen Willyoung** becomes promotion manager.

Capt. Ralph J. Johnson, UAL pilot, was named assistant supt. of the company's Pacific flight operations. **Victor J. Theimer** was named supervisor of tabulating, and **Floyd Drake,** principal of public schools at Bangor, Wis., for the past nine years, joins the Chicago engineering department. **Dale Medland** of UAL's personnel department was named employment manager for the company's system, headquarters in Chicago.

Lloyd Williams, formerly director of finance for Timm Aircraft, was appointed full-time executive secretary of the district Committee for Economic Development.

C. E. Stryker was named west coast representative of Bendix Products aircraft landing gear department.

Garet W. Denise is named general manager of Littelfuse Chicago plant operations.

Irmengarde Eberle, well-known writer, joins publicity staff of Railway Express air express division.

Hollis R. Thompson, v.-p. of American Airlines, was named head of the company's route development department.

Earle Stewart, Glenn L. Martin design engineer on landing gear, was elected to the SAE committee on wheels and brakes and re-elected to a committee on aircraft shock absorbers.

Jane Hutson, junior materials and process engineer, was appointed to technical committee "A" of the SAE and ASTM.

Col. Herbert K. Baisley has been named chief of the photographic laboratory of the AAF Materiel Command's engineering division at Wright Field.

Robert F. Black, president of The White Motor Co., was elected a director of Pennsylvania Central Airlines Corp.

Thomas C. Hill, controls design engineer at Glenn L. Martin, was advanced to head a new combined controls-hydraulic design group.

George F. Bauer was named chairman of the Metropolitan Air Shipping Committee by Aviation Section, N. Y. Board of Trade, and **Warren L. Baker,** Socony-Vacuum Co., domestic manager, aviation sales dept., was appointed chairman of the Metropolitan Fuels and Lubricants Committee.

Gus Leazar, flyer, airport engineer, and CAB safety specialist, was elected a director and v.-p. of Southeastern Air Service, and **James V. Carmichael,** attorney, was elected a board member.

N. J. MacDonald, v.-p. Thomas & Betts, was named chairman of newly organized Aircraft Electrical Council of NEMA.

McLean Stewart resigned as executive director of training for the CAA following completion of his work in the pilot training program. He will return to his work as v.-p. and chairman of Harriman & Ripley, investment bankers.

Lee J. Robison was appointed sub-division head of industrial and public relations at the Douglas Oklahoma City plant.

R. J. Delacy was promoted to subcontracting supt. of Convair's Vultee Field division.

All directors of the Boeing Airplane Co. were re-elected at the annual stockholders' meeting and organizational meeting of the board of directors.

George H. Clark, v.-p. engineering, Formica Insulation, was elected a director of the Society of the Plastics Industry.

Dr. L. G. Lederer, medical director of PCA, was appointed to the Rescue Operations Committee of the Natl. Safety Council.

Lt. T. W. Turner was assigned officer in charge of the Naval Training School at Glenn L. Martin.

Alex Raid, Northwest Airlines district traffic manager at Spokane, becomes asst. traffic manager at Chicago and is succeeded by **W. Robert England,** office manager and traffic representative from Seattle.

George French joins U. S. Plywood Corp. as production engineer. Formerly with the woodworking department of Western Electric, he has done industrial research for U. S. Forest Products Labs. and was a consulting engineer for the Natl. Lumber Mfrs. Assn.

Robert L. Coe, v.-p. Chase Brass & Copper, was re-elected president of the Copper & Brass Research Assn.

Edward L. Warner, Jr., former associate editor of "Automotive & Aviation Industries," was appointed manager of the aviation division of Automotive & Aviation Parts Mfrs., Inc.

C. Bedell Monro, PCA president, was awarded the honorary degree of Doctor of Laws, Marietta (Ohio) College, in recognition of his many contributions to the development and progress of commercial air transportation.

D. E. Dunlap, Douglas Aircraft engineering manager at Tulsa, returns to the home plant as executive engineer. W. L. Whittier, also at Tulsa, takes on the added duties of engineering manager of the plant.

Albert A. Arnhym, consulting engineer, Solar Aircraft, was named an associate fellow of the Institute of the Aeronautical Sciences in recognition of his pioneering work in the field of aircraft comfortization.

James P. Jeffrey was appointed personnel manager of Hamilton Standard Propellers division of United Aircraft, succeeding **W. T. Beebe** who becomes personnel manager of Pratt & Whitney at K. C.

Frank E. Dunn is named supt. of tool cribs for Consolidated Vultee's Ft. Worth division; **J. E. Crumbly** moves up as supt. of field operations; **Fred F. Gignilliat** becomes general employment supervisor; and **E. L. Williams** is now supt. of major assembly departments.

J. Nelson Kelly is named executive v.-p. of Fibre Locknut Corp., affiliate of Boots Aircraft Nut. He was first manager of Floyd Bennett and N. Y. Municipal Airport fields and was one time operations manager of Roosevelt Field.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Critical war materials were flown across oceans during the submarine blitz—**for safety.** If anyone, back in the Dole Race days, had predicted such a development, he would have sounded silly.

In three days, says Sir Richard Fairey, head of British Aircraft Commission, the industry in England could turn out enough planes to last all the world's commercial airlines for five years.

A man suggested to this department that it advocate putting all the world's fastest airplanes on a starting line and run them a hundred miles and see which one comes out ahead. But, of course, he said, they will all claim they could have done better at some other altitude.

Overselling aviation is an old and regrettable practice. In the public markets, it has damaged the sale of various aero items in the past. Anyhow, many light plane builders are planning to tell their customers exactly what their machines can do and can't do—so said customers won't re-sell them in disgust as soon as they find out they can't race P-38's with them.

Quite a number of the light plane builders are going into simplified control and non-stall design for post-war production. It looks as if the slow-and-safe school, sponsored years ago by the Aircraft Development Section of the Bureau of Air Commerce, may accordingly run even with, or ahead of, the old speed school.

More difficult than any aviation design, production, or operational problem, is development of a workable world air transport agreement. Britain and the United States seem to be trying to fox each other, and countries not consulted are resentful. Here at home, so many officials are taking part that some don't know what the others are doing. Reason for the long delay in forming a policy is that aviation is being used as a political weapon to force other issues.

Obituary

Capt. Lawrence J. Chiappino, Materiel Command, died recently in Dayton. Veteran TWA pilot, he had flown more than 2,250,000 mi. and had been loaned to AAF to run service flight tests on Lockheed "Constellation," participating in its record-breaking transcontinental delivery hop from Burbank to Washington on Apr. 17. Capt. Chiappino was a graduate of Univ. of Calif., and army flying schools at Brooks and Kelly fields.

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Also if your copy of AVIATION is late in reaching you, please bear with us. The delay is beyond our control—in most instances it is due to wartime transportation.

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Roll up your blueprints and specifications —dictate a letter outlining your needs— and dispatch your wiring problem to the nearest Whitaker plant. We welcome inquiries covering either war-time or post-war production . . . Backed by a quarter of a century of specialized experience producing wire and cable products, Whitaker has the facilities for large-scale production —plus the ability and "know-how" for quickly turning out cable assemblies to meet rigid specifications.

In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable products. There will be no obligation involved in your getting the facts, so why not write today!

WHITAKER CABLE CORPORATION

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Kansas City, Mo. · St. Joseph, Mo. · Philadelphia · Oakland

President Reports 170,000 Planes Built, May Total Was 8,902; Cutbacks Now in Sight

ACC states program . . . West Coast plants in new production phase . . . Termination bills up . . . New wind tunnels . . . Navy cancels "Conestoga"

President Roosevelt has announced that 175,000 airplanes were produced by U. S. plants between Mar. 11, 1941, date of enactment of the Lend-Lease law, and Apr. 1, 1944. He said that 33,000 of those planes were sent to the air forces of other nations. Allied governments paid for 7,000 of the planes, and 26,000 were delivered under Lend-Lease.

Charles Wilson, chairman of the Aircraft Production Board, and T. P. Wright, director of Aircraft Resources Control Office, reports that between Dec. 7, 1941, and May 1, 1944, the industry produced 171,257 planes having a total airframe weight of 1,430,000,000 lb.

Production of warplanes in May was 8,902, a monthly total exceeded only once before (9,118 in March). Record outputs of all three heavy bombers (Consolidated B-24, Boeing B-17, and Boeing B-29) were scored in May.

Despite design changes and increasing weight per unit, production in 1944 will come close to 100,000 in units and $18,000,000,000 in value. Unit output increased 3,400 percent from Jan. 1940 to Mar. 1944, as compared with a weight increase of 6,800 percent. Average airframe weight has increased from 3,600 lb. in 1940 to 10,000 lb. in 1944.

In 1936, Mr. Wilson said, Germany was building five planes to this country's one. The Nazis reached a maximum 27,000 in 1942 but were exceeded that year by the United States. Wilson estimates that Germany's output is now down 25 percent to around 20,000, or less than 1,700 per month. Japan's production, still figured to be going up, is calculated as between 1,000 and 1,500 per month.

See Production Cutbacks "Hitting" at Year-End

The inevitable cutback in production of warplanes is now in sight. If the war should continue on its present scale, reductions will be in order around the year-end. If Germany should show marked weakness or collapse before then, the cutback might come earlier. There will be curtailments or stop orders on some types as the character of war changes. Gen. Arnold recently said it would be ideal if the Air Force had but two fighters. The same reasoning applies to other military categories. It is hard to standardize on a few models because enemy strategy constantly demands new or revised designs to meet ever-changing conditions.

Navy's curtailment in overall production of fighters actually was merely elimination of over-quotas. Nevertheless, Navy is taking less than it could get—which amounts to the first aircraft cutback in this war.

Charles E. Wilson, WPB executive vice chairman, heads a new WPB panel to deal with cutbacks and cancellations.

ACC States Program; Lee Handling Reorganization

Fully supported by the industry, the Aeronautical Chamber of Commerce, headed by its newly elected president Eugene Wilson, is planning an aggressive postwar program. One of ACC's important initial steps is a publicity campaign for (1) practical government policy on termination of contracts and reconversion; (2) favorable policy on labor and taxation; and (3) promotion of U. S. air interests and strong air forces, backed by a sound aircraft manufacturing industry. Avery McBee, of Glenn Martin, is chairman of the Public Relations Committee.

John Lee, former manager of AWPC West, has taken over the reorganization of the chamber on a three-month basis. A permanent ACC manager had yet to be agreed upon at this writing. The AWPC's activity will taper off as the war nears an end, and the ACC will substitute peacetime services. The Aircraft Manufacturers' Council, a subdivision of ACC, will increase its functions.

Eventually there will be a new division in the Chamber as between airframe, engine, propeller, and parts manufacturers.

West Coast Plants Launch New Production Phase

Among West Coast plants, end of "preparations" and beginning of a new phase in the war is seen in contract terminations, shifts to other models, and negotiations for new contracts.

Douglas announces the approaching termination of its A-20 contracts; the Vultee Field division of Consolidated Vultee turned out its last BT-13 trainer (the 11,537th). Boeing prepared to switch its Plant No. 2 at Seattle to B-29's; Consolidated's San Diego division wound up its "Coronado" and "Catalina" production; North American announced it would transfer B-25 production to Kansas City; and Hammond Aircraft dropped first its "swing shift," then its "graveyard shift."

The Douglas termination, to be tapered off with delivery of the last A-20 some time in September, will affect 8,000 aircrafters. Hammond has dropped 1,200, most of them women. But Northrop announced its need to hire 2,000 to help step-up production of P-61 "Black Widow" night fighters. The Boeing and Consolidated shifts presumably will not considerably affect present personnel.

An AWPC memo pointed out that the shift to heavier planes further limits the percentage of women who can be employed because the work is too strenuous. It reminded that the full impact of selective service reclassification of plane plant workers hasn't yet been felt. Still in the plants, said this new memo, are hundreds of men who have been classified 1-A and will be inducted as soon as the armed services can absorb them."

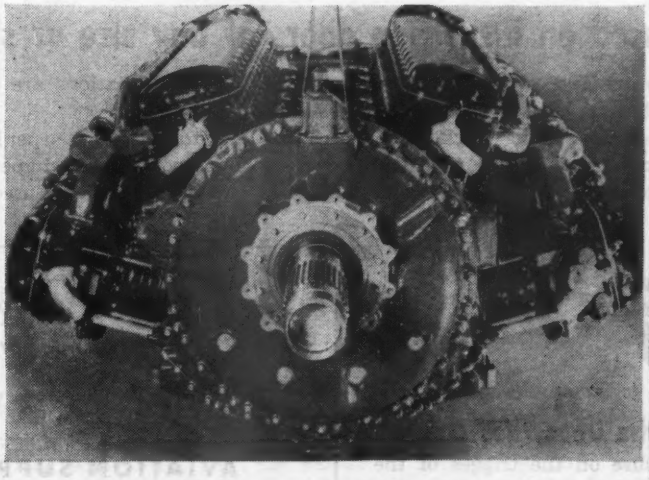
North American, though still producing B-25's at its Inglewood plant, proceeded with its preparations for removal of those lines to install P-51 facilities instead. Vultee, in announcing completion of its BT-13 contracts, stated its plant will be devoted to "combat craft projects." It has been operating B-24 engine, wing panel, and tail unit assembly lines for several months and recently added P-38 wing center sections.

Lockheed added its bit to the brighter side of the picture by releasing first photos of its new "Constellation" final assembly line, with a striking line of "Connies" tip to tip.

Termination Bills Up

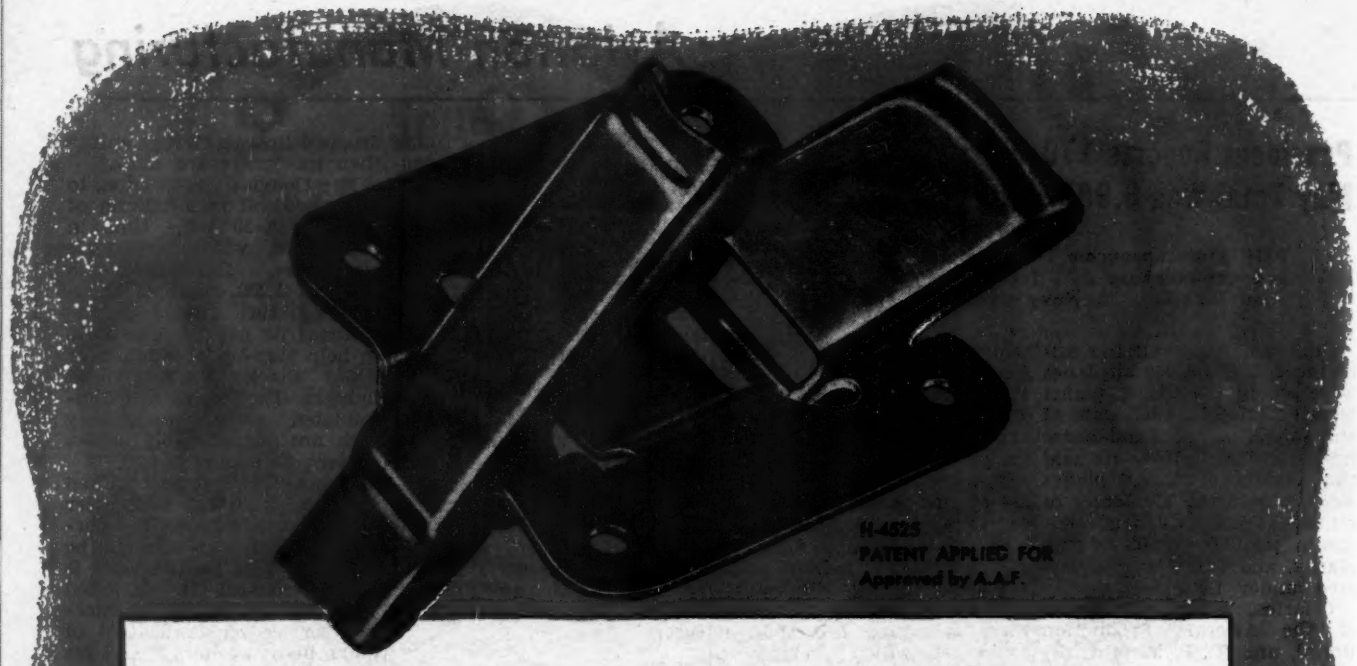
Legislation on termination of contracts is expected late in July. There are two bills: S 1718 by Senator Murray, and a bill by the House Judiciary Committee. These bills differ on questions of simplified appeal to courts from settlements by procurement agencies, and in methods of accounting. Most serious controversy centers on claims by the controller general of the Treasury that he should audit settlements before payments are made.

But probably both bills in their final form will limit the controller to post-audit of settlements only in cases where fraud is suspected. Nearly all government officials agree that settlement and payment should be expedited and that contractors should suffer no losses at the hands of the government.



ALLISON'S NEW "W" PACKS "3,000 HORSES"

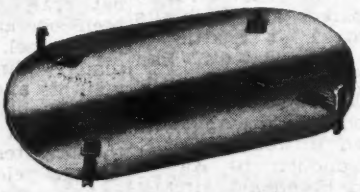
New 3,000-hp. Allison V-3420 series liquid-cooled engine features "W" design (four 6-cyl. banks). Weight per hp. has been reduced, and parts in power section are reported 97 percent interchangeable with Allison V-1710. Adding "hundreds of horses," new engine can be employed in either "buried" installation of large craft or in conventional fighter plane nacelles.



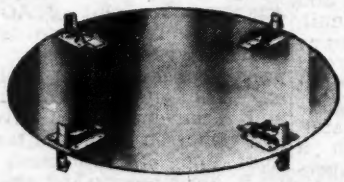
Puts planes in the air faster

Designed and engineered by Hartwell, this new inspection door latch, H-4525, can save as much as 30 minutes in the inspection of a single plane. It rivets to the inspection door, and *fits flush with the outer surface.* Weighs less than 1/3 oz.

The new Hartwell latch has been approved for use on aircraft by the Army Air Forces. Application has also been made for Navy approval. The latch can be installed in a standard Army Air Forces' cutout, shown on print 43G2853. It consists of four parts: trigger and bolt, made of light gauge steel, aluminum bracket, and twin springs.



Front view of Hartwell latch installation



Back view showing latches in open position

Can be used on inspection doors of any size or shape

Because of its design and construction, the Hartwell door latch can be used with *metals, plastic* or *plywood* of varying thicknesses, and on inspection doors of any size or shape. It can also be used without a hinge, where multiple latch installations are employed, as indicated above.

The number of latches used per inspection door depends upon its size, shape and load, and whether or not a hinge is used.

Press and the Door Flies Open!

Finger-tip pressure on the trigger of the Hartwell inspection door latch releases the bolt, permitting the door to pop open. Pressure on the bolt locks the door in place. It eliminates the former slow, tedious removal and replacement of inspection doors.

Single source for 779 different aircraft production parts and tools

HARTWELL

AVIATION SUPPLY COMPANY

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NACA Conferences; New Wind Tunnels

The NACA has conducted executive conferences at Cleveland and at Sunnyvale, Calif., for the East and West Coast sections of the industry, respectively. Technological means of putting greater pressure on the enemy were discussed. NACA has completed an altitude wind tunnel (at the Cleveland engine laboratory) capable of simulating temperatures encountered at 30,000-ft. altitude, and of evacuation to an air density of 50,000-ft. altitude. The tunnel can take propellers near 20 ft. in diameter, so that engines of 3,000 hp. can be tested.

Meantime, AAF Materiel Command announces that construction is underway at Wright Field on a funnel-shaped 10-ft. wind tunnel for testing models of high altitude bombers and fighters. It will generate winds of more than 600 mph. at temperatures as low as —67 deg. F. Temperatures and pressure conditions ranging from sea level to 50,000 ft. will be simulated.

Navy Cancels "Conestoga"

It is now revealed that Navy has cancelled its contract with the E. G. Budd Mfg. Co. for 175 of the company's "Conestoga" stainless-steel cargo planes. This is reported to put Budd back to a mere 25-craft order out of the original 800 total, since the Army has already cancelled a contract for 600 of these planes.

Navy, it was said, will meet its transport needs with Douglas craft. The statement mentioned delayed deliveries of the "Conestogas" and further "pointed to production costs substantially more than the company's original estimates."

Erratum

Through a typographical error, a formula was represented incorrectly in Richard G. Smith's article, "Graphic Simplifications in Computing True Airspeed" (May AVIATION). The wording (col. 2, page 155) was: ". . . the value of K (= actual temperature rise + adiabatic temperature rise). It should have read: ". . . the value of K (= actual temperature rise ÷ adiabatic temperature rise).

★ ASSEMBLY LINES ★

American Propeller Corp. has received new contract for additional propeller blades for Navy's Curtiss SB2C "Helldivers".

The 5,000th P-38 — 13,000th plane to come off Lockheed's assembly line—was painted bright red, named "Yippee", and highlighted ceremonies at presentation of "E" Award to company.

Also hitting 5,000 mark—for B-24's—was Consolidated Vultee, San Diego Div.

Westinghouse Electric's meter division is now producing electronic blind-landing instrument which guides pilots back to home fields.

Curtiss-Wright announces delivery of approximately 20,000 warplanes to the services to date. Between Jan. 1938 and Dec. 1943, 16,795 planes were built by company's six plants, 6,080 before Pearl Harbor.

Consolidated Vultee observed its second production anniversary with announcement that more than 2,000 bombers and transports had been turned out during past year.

Weyerhaeuser Timber Co. has commenced production of plastic molding compounds for commercial markets, at Longview, Wash., plant.

Aircraft production by Convair's San Diego Div. has entailed training of 78,704 employees and 8,000 supervisors.

B. F. Goodrich Co. will issue licenses for Leduc and Defour patents on high frequency heating in rubber applications. H. H. Glodvad Grell (33 University Pl., N. Y.) will issue licenses for application to plastics, wood, and other products.

Production - Battle Citations: Four Stars—Bullard Co., The, Farrel-Birmingham; Vendo Co.; Two Stars—Kiekhafer Corp., Alloy Steel Gear & Pinion Co.; Electromaster, Inc.; Switlik Parachute Co.; One Star—Fansteel Metallurgical Corp., Tantalum Defense Corp.; Berry Bros., Inc.; Caterpillar Tractor Co. Army-Navy "E"—Lockheed Aircraft Co., Panelyte Div. St. Regis Paper Co., Electric Sprayit Co., Voss Bros. Mfg. Co., Republic Aviation Corp., Douglas Aircraft Co. Superior Plant Guard Guidon—Cook Electric Co. National Security Award—Bausch & Lomb Optical Co.

★ FOR THE RECORD ★

General Controls Co. opened two new branch offices, at Boston and Cleveland, with William Marsh manager at former, L. E. "Rusty" Wetzel at latter.

The Bristol Co., Waterbury, Conn., opened a new branch office in Houston, Tex., with D. D. Ault as manager.

Revere Copper & Brass, Dallas division, opened a district sales office in Indianapolis under supervision of P. H. Anderson.

General Engineering Co. assets have been acquired by Thomas H. Speller, who will continue the business.

Helicopters, Inc., has now reorganized under the new name Bendix Helicopter Inc.

Worthington Pump & Machinery Corp., Harrison, N. J., has taken over the Electric Machinery Mfg. Co., of Minneapolis, synchronous motor and electric generator maker. Not long ago, Worthington also purchased Ransome Machinery Co. of Dunellan, N. J.

Photoprint Co. has changed its name to Template Reproduction Co., division of D. L. Ward Co., and has moved East Coast plant from Elizabeth, N. J., to 401 N. Broad St., Phila. (8), Pa. However, company's West Coast plant will continue to operate under old name at 1137 S. Olive St., Los Angeles (15), Calif.

Jacobs Aircraft Engine Co. has appointed L. E. McGivena & Co., N. Y., to direct its advertising.

Western Electric has taken a three-year lease on 290,000 sq. ft. of industrial property in St. Paul, Minn. The company will also take possession of DPC factory at Scranton, Pa., adding 87,000 sq. ft. of manufacturing space to Western facilities.

Eclipse-Pioneer Div., of Bendix Aviation Corp. announces opening of a new West Coast branch office to serve western users at 5655 Wilshire Blvd., Los Angeles.

Selas Corp. of America is new name of The Selas Co. No change is being made in organization, personnel, or service.

American Chain & Cable Co. has acquired Wilson Mechanical Instrument Co., maker of "Rockwell" hardness tester.

Offices for designing, consulting, aeronautical engineering, and airlines operations engineering have been opened by Frederic Flader in Buffalo, N. Y., under name Frederic Flader Co.

Reynolds Molded Plastics Div., of Reynolds Spring Co. has been acquired by Continental Can Co. No change in personnel, policies, or plant location is planned.

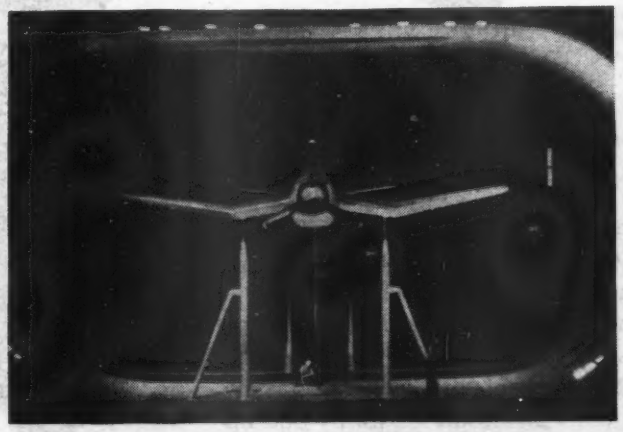
Cleveland Automatic Machine Co. has opened new district offices at Hartford, Conn., under managership of W. O. Aldrich, formerly special representative of Cleveland office.

Industrial Hard Chromium Plating Corp. has been formed, with headquarters at Newark, N. J. The new corporation holds exclusive manufacturing rights to hard chrome plating equipment under patents owned by Metals Protection Co., Indianapolis, Ind.

Rheem Mfg. Co. has purchased a large stock interest in Platt-LePage, helicopter manufacturers. Rheem, which will take an active part in the management, is licensed to use Platt-LePage patents and designs.

Glenn L. Martin Co. reports that production instrument section of its instrument laboratory has been transferred from engineering department to inspection department in line with policy to keep engineering research and development activities separate from production and inspection functions. Gordon T. Bell continues as chief of instrument laboratory in new set-up.

Midwest Aircraft Products interest has been sold by L. L. Duncan, who has retired as president. M. M. Culver, former v.-p. engineering, becomes president, and A. M. Fargo, secy.-treas., assumes additional duties as v.-p. charge of sales.



BIGGEST TUNNEL GOES INTO OPERATION

World's largest wind tunnel, capable of testing aircraft with spans up to 75 ft., recently placed in operation at NACA Ames Aeronautical Laboratory, Moffett Field, Calif., can measure lift forces of 180,000 lb. and drag forces of 32,000 lb. Six 6,000-hp. Westinghouse motors furnish power to circulate 24,000 cu. ft. of air through structure. New Douglas Navy scout bomber was first plane tested in huge tunnel throat (80x40 ft.), size of which is indicated by men seen at base of supports. With tunnel determination of undesirable characteristics, corrective measures can be applied direct to full-size plane. Tunnel will also act as check on smaller wind tunnels in which only models or parts of planes are tested. Relationships determined between tests on models and on actual planes will lead to new accuracy in checks on models representing larger aircraft too big for mounting in tunnel.

★ KNOW-HOWS ★

Automatic "hardness certifier" to test sheet metal parts and impress personal inspection and heat-treat stamps in one operation has been devised by A. Vicek, Glenn L. Martin Co. inspector. If metal is too soft machine remains inoperative. It is stated to save half time formerly required.

Lubricating oil compounded to thicken when heated and thin when cooled in order to give more efficient operation of engines through wide temperature ranges is new experimental development announced by California Research Corp., a Standard Oil subsidiary.

Made of duPont "Lucite," new airfield guide-light lenses are stated to provide good weather resistance and dimensional stability while affording a sharp reduction in weight, which is important consideration because equipment must be light for quick transportation and ease of handling required in swift advances of air forces to new bases. Lenses were developed by Stimson AGA Plastics, Chicago.

Target for Tomorrow

WHEN you take a grip on this Lumarith training model of a Colt 45 (molded over metal) you may not think right off of a postwar automotive steering wheel (or even of Lumarith warplane controls). But the analogy is there.

The army indoctrination "gun" fits your grip perfectly. Its fine balance and business-like detail give a sense of confidence. Agreeable temperature comforts your hand.

These are qualities important to future automotive steering wheels, handles and knobs—improved grip, better looks, more comfort—all assured by Lumarith, the foremost plastic for molding over metal. These are advantages inherent in the toughness, lightness and thermal stability of all Celanese plastics, plus high flexibility and impact strength, surface and color permanence, moisture resistance.

Unlimited choice of color and the big range of Lumarith formulations for molding over metal (and assuring compatible expansion and contraction coefficients) provide materials precisely suited to individual jobs.

*Reg. U. S. Pat. Off.

P.S. Our Technical Staff talks your language. Celanese Celluloid Corporation, The First Name in Plastics, a division of Celanese Corporation of America, 180 Madison Avenue, New York City 16.

Executive Order Increases Airline Fleet To 300 Planes, Two "Surplus" Plans Offered

Minnesota upheld against Northwest . . . USSR, China in air policy talks . . . ATC's third birthday . . . Court backs CAA code . . . Federal-state field plan urged . . . EAL, Braniff, National win safety awards

Maximum fleet to be operated by the airlines has been "upped" by executive order from 200 to 300 planes. For military work, Army has liked Douglas DC-3's as well as its own Douglas C-47's, mainly because of the small doors, and some observers believe the airlines will get back enough of their requisitioned ships to reattain their prewar fleet of 350.

Col. Edgar S. Gorrell, Air Transport Association president, explains that the airlines gave up, by sale and lease, a total of 650 airplanes —that is, 45 to foreign governments, mostly to Britain; 295 to the armed services; and 310 on order with manufacturers or approved by WPB for delivery.

Transport operators, especially the smaller ones, have a hard job converting the returned planes from military to civilian use. All operators have difficulty finding crews to fly them, but release of pilots from the discontinued WTS program is easing this problem. Chances are that some small airlines will be released this year from the ATC contracts for domestic operations.

Probably some suspended airline schedules will be restored as planes are returned. The average prewar workday for a plane was 7 hr. Now it's about 12 hr. Thus, the fleet of 300 planes already authorized will do 3,600 hr. per day, as compared with 2,450 hr. per day by 350 planes before the war.

Offer Two Disposal Plans For War-Surplus Craft

Two plans for disposal of war surplus transport planes have been proposed. The Pogue Aircraft Subcommittee of the Surplus War Property Board suggests that the airlines be permitted to lease as many of the planes as they want for five years, with privilege of terminating the lease upon purchase of new replacements from manufacturers. And Air Transport Association urges in addition a proposal that airlines be permitted to do conversion work on planes themselves. However, manufacturers object; they want each plane returned to its original designer for conversion.

Second disposal plan is one favored by some aircraft manufacturers. They suggest that U. S. military transport planes be sold to operators the world around, who will obtain parts from the U. S. makers, accustom themselves to U. S. planes, and buy new equipment of the same types. Opinion is there would be enough surplus transports to make both plans feasible.

USSR, China in Air Policy Talks at Capital

The business of formulating a postwar overseas air transport policy is deeply involved in international politics. Delegations of five Russians and three Chinese have been in Washington, talking with the State Department's air group. Latter is headed by Joseph C. Grew, who is technically advised by CAB Chairman Welch Pogue and Assistant Secretary of Commerce William Burden.

Assistant Secretary of State Adolph Berle recently conferred in London with British air authorities. Later, during a House of Lords debate on international air policy, Lord Beaverbrook said that the British consider the United States committed to an effort to obtain a world agreement providing right of innocent passage and technical stops. Beaverbrook based this conclusion on President Roosevelt's remarks at a press conference months ago. Observers believed at the time that Mr. Roosevelt was quoting from the secret report of his Interdepartmental Committee on International Aviation.

The British debate indicated the two countries have agreed to seek, at the forthcoming international air meeting, establishment of a world body which would govern world air transport.

Minnesota Upheld in Case Against Northwest

State taxation of interstate air transport properties will be an issue for a long time. On May 1, 1939, Northwest Airlines computed its personal property tax on the basis of planes in Minnesota on that day. Minnesota disagreed—assessed all planes owned by Northwest. The company appealed from a state court ruling for the state, and the Supreme Court upheld the Minnesota court five to four.

Chief Justice Stone wrote the minority's view that the tax was unconstitutional. Justice Jackson, concurring with the majority, said the court would need the help of Congress in solving the problem. CAB has suggested that Congress act upon the question. As a result of the court's two-sided decision, there is revived interest in the sidetracked Lea Aviation Bill (HR 3420) calling for a Civil Aeronautics Commission, which would consult with the states to avoid multiple taxation.

Federal-State Field Plan Urged at Air Forum

Addressing one-day Southwest Civil Aviation Forum, held at Oklahoma City, May 26, CAA Administrator Charles I. Stanton advocated a federal and state government partnership in establishing the nation's postwar civil airport system. It should, he said, include approximately 6,000 airports.

Stanton declared that federal funds should be made available to states on a formula basis, taking into account four factors—area, population, number of aircraft, and number of existing accredited airports. Under his plan, each state would have to match a percentage of its quota of federal funds. Foreseen was operation of 300,000 civilian planes within four years after the war.

A feature of the forum was a question-and-answer program in which representatives of 16 cities in three states took part.

New Heli-Bus Project

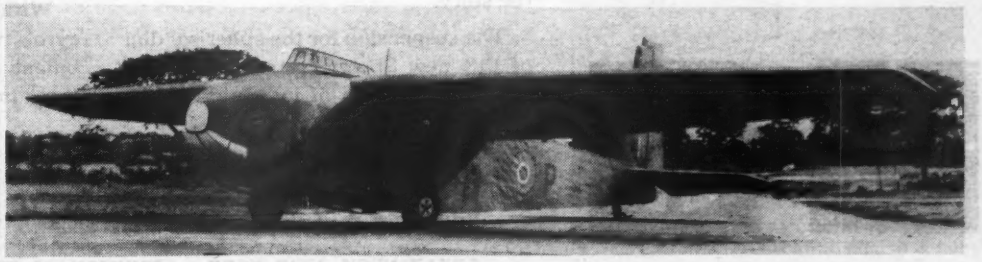
Faith in the future of commercial helicopters continues boundless. Arthur Hill, president of the Atlantic Greyhound Corp., announces that the bus industry proposes to establish helicopter-bus service to 1,000 towns and cities, without subsidy. Operating over 50-to-200-mi. distances, such service, he said, would carry the multitude who are entitled to the benefits of aviation.

EAL, Braniff, and National Win Safety Awards

Awards were recently made by the National Safety Council in connection with its Air Transport Safety Contest covering 1943. Sixteen of 17 domestic airlines were noted to have flown 1,225,000,000 mi. without a fatality, and on a passenger-mile basis, the record was stated to be 180 percent better than in '42—75,873,368 passenger-miles per passenger fatality.

Group A award, for lines flying more than 100 million passenger - miles annually, went to Eastern Air Lines; Group B leader (from 10 to 100 million passenger-miles) was Braniff Airways; and Group C (less than 10 million passenger-miles) was led by National Airlines.

Special certificates went to Chicago & Southern, Colonial,



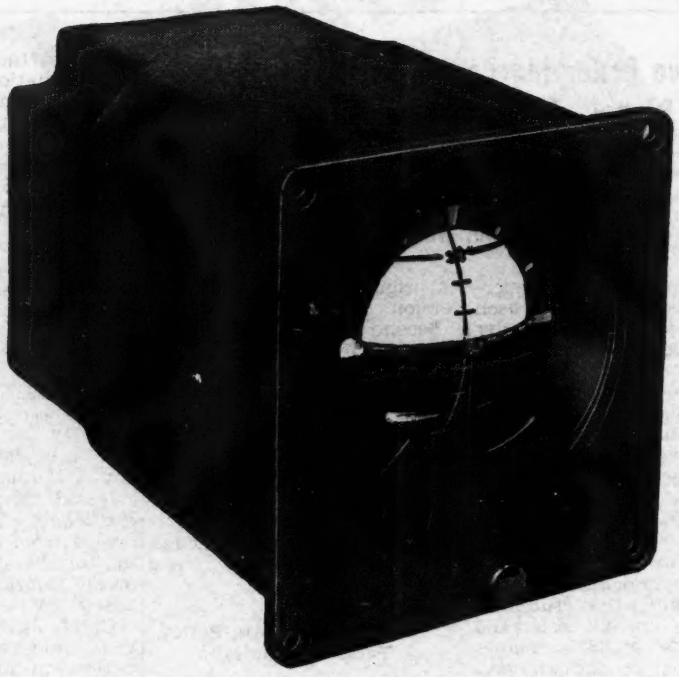
"BOMBER-SIZE" GLIDER

New giant glider, British "Hamilcar", used for large-scale airborne invasion landings, has nose-access compartment to carry light tank. Glider, with span exceeding the 102-ft. of "Lancaster" bomber, requires towing by plane of "Albemarle" type. (British Combine photo.)

Pattern indication gives the pilot a visual "picture" of his attitude at all times, regardless of the degree of bank, climb, or dive.

No angular limitations! The Sperry Attitude Gyro indicates pitch and bank without any angular limitations!

No caging! Because there are no angular limitations, the instrument *never* has to be caged . . . not even in acrobatics!



Attitude Unlimited!

New Sperry Attitude Gyro provides pattern indication . . . has no angular limits . . . needs no caging!

WITH THE NEW Sperry Attitude Gyro Indicator a pilot can, *for the first time,* loop, roll, dive, climb, or fly at any angle with visibility zero, and still always know the attitude of his plane relative to the earth.

The spherical dial is marked to provide the same "pattern" type of indication whether by daylight or by any artificial light . . . a single glance tells the story.

The suspension for the spherical dial of this new Sperry instrument allows full 360° freedom of indication in the roll and pitch axes of the airplane.

A small gyro spinning at 23,500 r.p.m. stabilizes the sphere and keeps it erect in relation to the earth's surface. *The airplane actually maneuvers around the indicating sphere.*

The Sperry Attitude Gyro makes instrument flying safer, easier, and facilitates maneuvers and acrobatic training.

With it there is no possibility of the gyro's tumbling, even in extremely turbulent air. And, of course, its advantages in combat are obvious.

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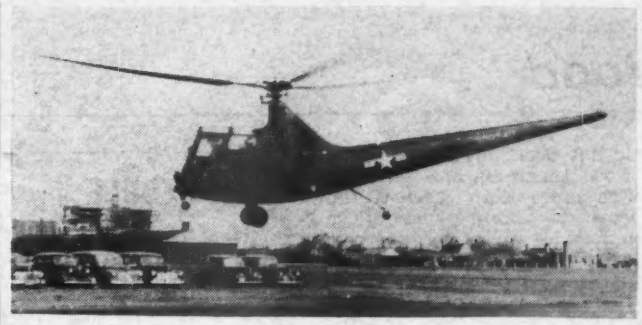
Continental, Delta, Hawaiian, Inland, Mid-Continent, Northeast, Northwest, Penn-Central, TWA, UAL, and WAL. To Wright Aeronautical went a citation for performance of company's "Cyclone" engines in transports of three winning airlines.

Court Backs CAA Code

Federal authority to require all civil planes and pilots to be certificated by CAA was recently tested in the Reno, Nev., U. S. District Court, which upheld CAA's recent assessment of penalties against a Nevada pilot for violating the civil air regulations, forbidding him to operate airplanes until he obtained a CAA pilot certificate.

ATC's Third Birthday

Army Air Transport Command celebrated its third birthday May 29. Having become by far the world's largest air transport and ferrying system, invasion found it playing one of the most important roles in the war. Its personnel has grown to 20,000 officers, 88,000 enlisted men, and 20,000 civilian employees. In Apr. 1944, ATC flew 29,000,000 airplane ferry miles and 20,000,000 transport service miles, mostly abroad. In March, 60,000 persons were flown to scattered destinations. The ATC, now adding 200 new transports, will take over all operations of the Army Air Transport Service within the continental U. S. before the year's end.



SIKORSKY'S "5" AND "6" IN ACTION

Latest Sikorsky helicopters, XR-6 (top) and XR-5 (above) are more streamlined and faster than earlier R-4 model. Powered with 245-hp. Franklin aircooled and P & W 450-hp. "Wasp, Jr." engines, respectively, these craft can do better than 100 mph. Conventional anti-torque rotors are employed on tails of ships. Feature in each is provision for carrying externally a litter for wounded on each side of maximum-visibility cabin. XR-5 is to be made at Sikorsky plant, while Nash-Kelvinator will build XR-6.

★ CROSS COUNTRY ★

South American Republics celebrated the 15th anniversary of the first airmail service linking the U. S. with Peru, Colombia, Ecuador, and Chile.

Braniff Airways marks its 10th anniversary of flying mail. When it was awarded the U. S. mail contract in 1934, two Lockheed "Vegas" carried approximately 111 lb. of mail between Chicago and Dallas. Today, company's DC-3's carry as much as 3,000 lb. plus passengers, in each direction on same route. Word also comes that company's application to serve Lubbock, Tex., on its Dallas-Amarillo-Denver route, has been granted by CAB.

Pan American Airways "Clippers" have re-opened service across North Atlantic. Regularly scheduled mail, passenger, and express service will continue through summer. Since inauguration of these flights, "Clippers" have carried 60,000 passengers and flown 10,000,000 mi. in 1,875 scheduled Atlantic crossings.

War Department recently authorized $2,395,000 to provide for fills and extension of two landing strips at San Francisco Municipal Airport as part of $10,000,000 to be spent on improvements at Mills Field by Army and Navy. Agreements entered into by city and federal government in April guaranteed improvements in exchange for deeding of Treasure Island in San Francisco Bay to Navy.

A calendar has been prepared by UAL for air shippers giving quick reference material on maximum cargo sizes, DC-3 door dimensions, types of materials that can be shipped by air, rates, priorities, etc.

All American Aviation celebrated 5th anniversary of its air mail pickup, inaugurated May 12, 1939.

Southwest Airways set a new record in April when its planes flew 99.6 percent of scheduled mileage on its California-based ATC feeder routes for Army. They missed perfect score when weather prevented one plane from reaching final station.

United Air Lines has applied to CAB for a route from Seattle to Ketchikan, Juneau, Yakutat, and Anchorage, Alaska. Proposed airway is approximately 1,500 mi. long. Company officials believe passengers and cargo could be flown from N. Y. to Juneau in 16¼ hr. and to Anchorage in 19 hr. Elapsed times from Seattle to Ketchikan would be about 3 hr., to Juneau 4⅓ hr., to Yakutat 5¼ hr., and to Anchorage 7 hr.

UAL has again modified its stewardess qualifications, maximum height now being increased from 5 ft. 5 in. to 5 ft. 6 in. and maximum age from 25 to 26. Other requirements: Minimum age 21, minimum height 5 ft. 2 in., maximum weight 125 lb., and 20/30 vision. Since war, United waives requirement of nurse certificate, substituting two years of college education.

Plans by Colorado Public Utilities Commission to regulate intrastate aerial transportation in same manner as ground carriers is being opposed by Continental Air Lines, United Air Lines, Braniff Airways, and Inland Airways, which say such a code would cause confusion and is not needed for air carriers operating under federal authority. Proponents, Maj. Ford Williams and E. B. Evans, contend CAB regulations do not meet problems arising from feeder line operations. Intrastate airlines did not challenge commission's authority.

Contract for construction of a 1,300 ft. runway extension and additional taxiways at Cheyenne, Wyo., airport have been awarded to Peter Kiewit Sons' Co., Omaha, and Big Horn Construction Co., Sheridan, Wyo., joint low bidders at $200,000. Financed by CAA, extension will make Cheyenne runway 8,000 ft. long.

What is believed to be fastest flight between Anchorage, Alaska, and Seattle—6 hr. 43 min. for the 1,500-mi. trip—is reported by UAL, flying for Air Transport Command. Pilot of plane, a Douglas C-47, was Capt. Hugh C. Worthington. Only one stop was made en route (at Annette Island), and with strong tail winds average speed was 225 mph.

Central Airlines has filed an application with CAB to start an intra-state, non-scheduled service between Oklahoma City, Duncan, and Lawton. This new $100,000 corporation plans to transport passengers on a contract basis. Founder and president is Guy O. Marchant, v.-p. and gen. mgr. is Keith Kahle, operations manager and chief pilot is L. L. McMillon, and traffic manager is Edwin Keith Cornish.

Three organizations. — UAL, Wayne University, and the Great Atlantic & Pacific Tea Co.—have joined forces to explore postwar possibilities of shipping perishables by air.

Fourteen planes returned by Army to civilian use will go to airlines as follows: Braniff 1, UAL 3, PCA 2, TWA 3, American 2, EAL 2, and Chicago & Southern 1.

The New Feeder Airlines Assn. held its first permanent organization meeting in June.

American Airlines figures for first four months of 1944 compared with same period in '43, are: 9,139,748 revenue miles, an increase of more than 800,000; 142,569,825 revenue passenger miles against 130,978,554; more than 10,000,000 lb. of mail, an increase of 3,000,000; 6,304,246 lb. express loads, an "up" of 435,264.

Colonial Airlines added additional trip between New York and Montreal, bringing daily round-trip total between these points up to four.

TWA recently inaugurated new daily (except Sun.) round-trip all-cargo flight between New York and Chicago, in addition to its daily transcontinental round-trip cargo-flight. Also, company has applied to CAB for round-the-world air route to bring any point in itinerary within 38 hr. of N. Y.

Declaring his cows, pastured near Allentown-Bethlehem, Pa., airport, were frightened by low-flying planes, farmer Frank Dlugos got an injunction ordering aircraft to keep higher than 100 ft. over his fields. Accordingly, UAL had to discontinue landings at the port. Now, however, a rehearing has reversed order and airliners are again operating at A-B field.

Approval for construction of 14 airports required for specific military purposes and 27 for emergency use was recently announced by Secretary of Commerce.

Braniff Airways employees now receive aircraft electrical systems course under Illinois Inst. of Tech. "in service" training program. Course is given in company plant and paid for by U. S. Office of Education.

Transport-plane models now under construction will carry transatlantic traffic until 1952, possibly longer, in the opinion of William Burden, Assistant Secretary of Commerce. Talking at a recent meeting of the Foreign Commerce Club in New York City, he predicted a transatlantic fare of $250 per passenger.

Poll taken by Des Moines, Iowa, "Sunday Register" indicates a third of state's residents have flown, that women are almost as airminded as men, and that nearly as many farmers as urban dwellers have taken flights. To question, "Have you ever thought you would like to buy a plane for your own use?", 21 percent said "Yes," six percent replied, "Perhaps."

Railway Express Agency has conducted a quiz contest among its many thousands of employees aiming to bring greater awareness of the work of its air express division. A total of 13,805 employees in 1,500 communities participated.

Aviation Abroad

British 12-Mo. Production Totaled at 27,273 Planes

Atlantic flown 15,000 times since start of war.

In the first detailed statement made thus far, Sir Stafford Cripps disclosed actual British plane production figures for the past years. With 27,273 new aircraft completed in the year ending Mar. 31, 1944, the industry, which now employs more than four women for every ten workers, showed an increase of 82 percent over 1940 and 240 percent over 1939. In addition to the 27,000 new planes, the industry rebuilt more than 18,000 others, thus actually making more than 45,000 aircraft available for combat. An earlier announcement gave 90,000 planes as the total British production since the beginning of the war.

Sir Stafford pointed out that spare parts constituted an additional 60 percent of the total production, which would make the net production more than 43,000 planes for the year. It must be noted that while the figures may appear low, England for a considerable period was under heavy and constant air attack. Still its industry consistently managed to bring out new models.

Atlantic Flown 15,000 Times Since War's Start

A recent British Air Ministry report showed that the Atlantic has been flown more than 15,000 times since Sept. 1939, with more than 5,000 of the crossings taking place in the periods between December and May. Little more than 75 planes have been lost to date, the majority during the beginning of the program. The announced figure includes all military ferry flight and transport command traffic crossing in both directions, but it does not include any flights made by commercial airlines. Most recent figures indicate that a plane leaves every 45 min., while at least 25 planes are en route across the ocean at any time of the day.

★INTERNATIONAL BRIEFS★

A modification of FW-190 (probably known as 290) features a new 2,000-hp. in-line engine. Performance is not known yet, but it should be shown "upped" by this increased power.

Reports from England say a new "bomber-killer" plane featuring prodigious climb and firepower is now in full production. This job is probably Hawker "Tempest."

Add to list of new British commercial planes the Short "Shetland" flying boat, first model of which is being readied.

According to latest reports, Germany's best glider bomb can be controlled from 18,000-ft. distance. This is improved Hs-293, generally carried by He-177 bomber.

Henschel is also building a new fighter known as Hs-219. So far it's seen only limited action.

ON SCHEDULE . . . . . By "VISTA"

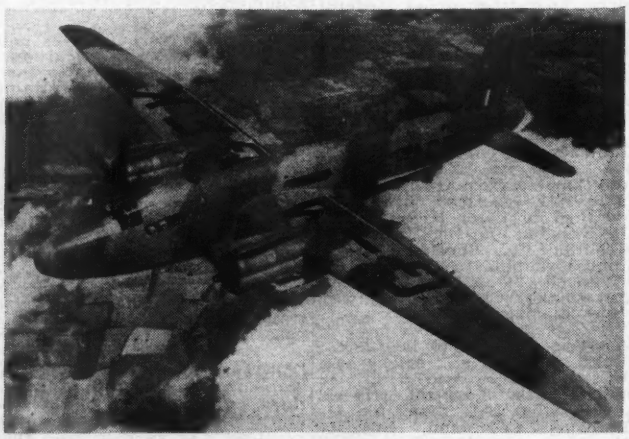
Pertinent details on airline operations in Central and South America have been made public by the DSC. On the last day of 1943, there were a total of 386 aircraft in operation in these countries, of which only 57 were U. S.-flag aircraft. Of these craft, 246 were multi-engine, but only 97 were manufactured after 1936. Among the multi-engine planes, American built equipment predominated, accounting for 199 of the total, while 29 were of German manufacture and 18 were built in a miscellany of other countries. There were a total of 113,900 route miles in operation.

Mexico had 18,400 local-service miles of Central America's 37,000-mi. total. In South America, Brazilian internal services accounted for 33,500 of the total of 60,900 mi. Foreign-line aircraft utilization stood at a remarkably low figure of 2.4 hr. (25 percent of the U. S. average), with 5.8 hr. for U. S.-flag operators. Total ton-miles sold amounted to 62 million, compared with 215 million over 42,650 mi. of routes in the U. S.

Britain's magazine *Aeronautics* recently carried details on current operations of the Belgian SABENA. Maps show that this airline has quietly developed an astonishing network of lines in Africa, connecting the Congo with Cairo, Capetown, and Takoradi on the Gold Coast, also with extensive services within the Congo.

While this line's postwar plans only mention resumption of its previous European and to-Africa routes, further extensions to Poland, Russia, the Balkans, and Near East are anticipated. The line, which used Savoia transports for some time, recently purchased its first DC-3's.

KLM has completed its 2,000th England-Lisbon flight, a landplane service started in May 1940 and which has carried over 11,000 passengers with the loss of only one plane (that which carried Actor Leslie Howard and KLM Pilot Tepas). Three of the six original DC-3's are still in use, and three planes have recently been replaced by Douglas C-47's under American lend-lease.



P & W-POWERED "WARWICK"—COMPLETE WITH FOOTPRINTS

Second new commercial plane to appear in England is this Vickers "Warwick" mid-wing monoplane which, with Avro "York," is becoming a standard transport for RAF. A bigger sister of famed "Wellington" bomber, "Warwick" is some 20,000 lb. heavier, grossing 45,000 lb., but has only 10 ft. more span (96 ft. 8½ in.) and 6 ft. more length (70 ft. 6 in.). Height is 18 ft. 6 in. and gross wing area 1,006 sq. ft. Mounting two P & W 1,850-hp. engines, plane's top speed is expected to approach that of "Wellington III" (some 265 mph.). Notable features are geodetic construction, sharply tapered wings, and very long engine nacelles. Black marks on wings are painted footprints—a precise indication of restricted walkways to guard against damage to underlying "basketweave" construction. (British Combine photo.)

Richard Archbold's "Guba" flying boat (Consolidated PBY) has finally been retired from BOAC fleet after many years of service.

Rolls-Royce has built more than 100,000 "Merlin" engines since July 1937.

German "Siamese Twin" glider tug—two He-111 bombers joined together—mounts four DB601N in-line engines, plus one BMW801 radial engine at joining point of two planes.

Production of "Albemarle" glider tug has been taken over by a new British firm, A. W. Hawsley, Ltd., a subsidary in Hawker Siddeley group.

Australia plans manufacture of an in-line liquid-cooled engine of an as yet undisclosed type, also several transport type craft for postwar use.

At least twelve companies have registered in India for postwar commercial air transportation.

Nazis have been using new Arado Ar-240 reconnaissance airplane over England (said to be slow and hence easy prey for Allied fighters).

It's said Germany is developing her monster Me-323 "six-engine glider" into a bomber.

Qantas Airways of Australia offers following 1943 resume: 18,231 passengers carried 17,375,000 mi. plus 1,376,000 lb. freight and 327,000 lb. mail. Line now employes nearly 1,600.

Swedish ABA again has suspended its Sweden-Scotland service due to British travel restrictions, but it may re-open its route to Moscow via Baltic states.

Two new records have been set by "Mosquitos"—one flew Atlantic in 6¾ hr., another covered distance from London to Moscow in 4½ hr.

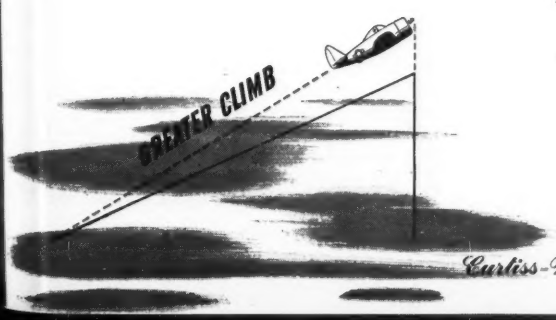
A new Portuguese airline has been formed—Aero Portuguesa Limitada. It proposes air routes to Portugal's colonies and Brazil.

Reports indicates Heinkel has developed a transport plane, known as He-274, from the He-177 bomber, featuring four engines in two nacelles end driving contra-rotating propellers.

SNCA du Midi is building a special plane for flights at 50,000 ft. It is to feature a pressure cabin, mixed construction, two Hispano 12Z engines inside pressure section of fuselage, and contra-rotating propellers. SNCA du Midi is a French organization.

knockout specialist from stratosphere to sea level

Having won a reputation as master of the stratosphere, the Republic P-47 Thunderbolt now demonstrates its power as a low-level fighter-bomber in clearing the way for invasion. After attacking without warning at tree-top levels, the Thunderbolt speedily heads skyward at a new, faster rate of climb—aided by new wider Curtiss Hollow Steel blades.



CURTISS ELECTRIC PROPELLERS

Curtiss-Wright Corporation, Propeller Division

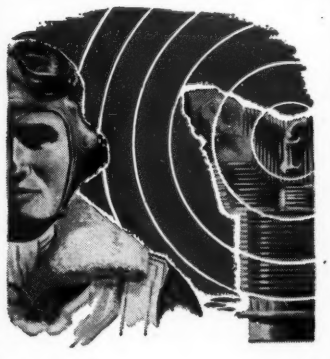
CLEARING all Wires!

Breeze Flexible Conduit Shields and Protects Communications and Wiring Systems

Any current-carrying wire in an aircraft electrical system is a potential source of interference with radio communications unless properly shielded. Breeze Flexible Shielding Conduit, produced in a wide range of diameters, can be used in conjunction with Breeze Conduit Fittings and Multiple Electrical Connectors to meet practically any shielding requirement.

The custom design of complete radio ignition shielding harnesses is a Breeze specialty, based on years of pioneering experience in the field.

Breeze Flexible Shielding Conduit is in service today with fighting units of land, sea, and air, supplementing the many other well-known items of Breeze equipment that are helping the United Nations along the road to Victory.



Breeze Shielding guards communications against high frequency interference from spark plugs and ignition system circuits.

Breeze BREEZE

CORPORATIONS, INC. NEWARK, N. J.

PRODUCTION FOR VICTORY • PRODUCTS FOR PEACE

Douglas Aircraft Co. has arranged a $75,000,000 revolving credit with 17 banks—the largest credit ever floated by an aircraft manufacturer without involving a government credit. The new credit is for three years, with the company agreeing to maintain a $25,000,000 minimum net working capital. Douglas working capital topped $35,000,000 at the end of 1943.

Cessna Aircraft Co. has voted a 100 percent stock dividend, increasing the outstanding stock from 350,000 to 700,000. Another 800,000 remains in the treasury unissued and the company does not contemplate any financing at this time.

Grumman Aircraft stockholders it is understood, will be asked to increase the authorized capital stock from the present 600,000 to 3,000,000. The increase will be requested so that the company will be in position to raise money by stock sale if it is needed at some future time.

Bendix Aviation reports net income of $14,722,704 or $6.95 a share for the year ended Sept. 30, 1943 against net of $12,464,196 or $5.90 a share in the like 1942 period. Net sales were $822,510,234 compared with $459,169,026 in 1942. Expenditures for research and production engineering were $14,900,000 against $11,700,000 in 1942. Last year 82 percent of total volume went into the aircraft field.

Loans: Continental Motors Corp. has negotiated a $30,000,000 VT-credit with 18 banks. . . . Aircraft Accessories Corp. has established a $12,500,000 V-loan with 12 banks. . . . The Square D Co. has arranged a V-loan with several banks to provide capital for war production and to free working capital during the immediate postwar adjustment period. The terms prohibit payment of cash dividends equal to more than 75 percent of annual earnings after preferred charges. It was also agreed not to permit net current assets to fall below $3,200,000, this amount to be increased at the end of each year by 20 percent of net profits.

Fairchild Camera & Instrument Corp. (formerly Fairchild Aviation Corp.) reports net sales of $47,559,896 in 1943 against $15,284,387 in 1942. Net profit was $1,449,110 or $4.29 a share against $407,644 or $1.20 in 1942.

ADDING IT UP.....By RAY HOADLEY

Came the deluge. Most of the airlines are more than pleased with the rapidity with which the Army has been releasing transport planes to them recently. In fact, after the last 28 were returned some lines said they had just as soon have a little breathing spell before very many more came their way because of the personnel factors involved. The lines are determined to maintain their current safety record above all else. Meanwhile, this additional equipment will greatly step up 1944 traffic volume, although little if any of the extra business will seep down to net profits.

Foggy weather. The Supreme Court decision in the Northwest Airlines state tax case has the airlines worried because of the ruling that states in which lines are incorporated may tax the full value of the company's fleet of planes. No opinion was given regarding the tax rights of states through which the planes fly. The best bet for the airlines seems to be to convince Congress that it should include a provision, in one of the pending postwar bills, limiting such state taxation. The high court indicated that Congress has the power to enact such limitations.

Warplane cutbacks. Cancellation of Brewster's Navy contracts served to bring into the open a matter which has bothered all plane makers lately. With Brewster the "guinea pig" in the situation, both government officials and Congress can see the wide ramifications, both political and economic, of abrupt cancellations. The rest of the industry will benefit from the Brewster experience through provision of more reasonable notice in the future, with gradual reductions in operations and better government planning to find other war work for idle plants and facilities.

Dismissal pay. It is becoming a generally accepted fact that provision for released war workers is a responsibility of government. Any private monetary solution to the problem would, of course, bankrupt most aircraft companies. It is noted that even the automobile concerns have no plan to cope with unemployment when contract cancellations flock in. These companies appear to be relying on benefits provided under state unemployment compensation laws.

Surplus inventories. Plans whereby aircraft manufacturers can turn over excess inventories to the RFC will enable the companies to get rid of inventories that would prove an intolerable burden in the event of sudden cancellation. It is expected that the plan will start functioning early in the fall. The effect on many a company's cash position at the year-end should be most favorable.

National Airlines is selling 113,333 shares of common stock. The proceeds of the issue will be available for general corporate purposes pending specific application.

Airline Earnings: Eastern Air Lines reports net profit of $179,520 or 30c. a share in the March quarter against $278,296 or 47c. a share in the like 1943 period. . . . TWA reports a first quarter net loss of $92,419 against a net profit of $357,352 or 37c. a share in the like 1943 period. . . . United Air Lines reports net income for the quarter of $1,110,083 or 66c. a share against $1,178,779 or 79c. a share in the same 1943 quarter. . . . Western Air Lines showed a net loss of $17,564 against a net profit of $21,667 in the like 1943 period.

Dividends: Glenn L. Martin Co. declared a $1.50 common dividend payable June 12. . . . United Aircraft made a similar payment on June 15. . . . Other second quarter payments were: From Continental Motors, 15c.; Delta Air Lines, 50c.; Air Associates, 20c.; Grumman, $1 a share; Rohr Aircraft, 25c.; Bell Aircraft, $1 a share; United Air Lines, 50c.; and Bendix, 75c.

Backlogs: Bendix Aviation meanwhile reports that unfilled orders on Mar. 31 were $791,200,500 compared with $1,018,901,000 on Sept. 30 and $1,074,468,500 on Mar. 31, 1943. . . . The Douglas Aircraft Co. has almost $3,000,000,000 in unfilled orders, which it would take three years to complete at the 1943 production rate . . . Glenn L. Martin Co. has letters of intent which call for some additional facilities and a higher employment this year.

Continental Motors Corp. announces sales of $196,498,812 in the year ended Oct. 31, 1943 against $126,389,000 in 1942 and $31,564,000 in 1941. Net profits were $7,493,820 or $2.50 a share against $5,472,884 or $1.82 in 1942.

Production Outlook: Republic Aviation, now operating at peak levels on the "Thunderbolt," does not expect any cutbacks this year. . . . Pres. Breech of Bendix expects dollar volume for Bendix products in the 1944 fiscal year will not exceed that of 1943. . . . Consolidated Vultee Corp. anticipates a larger 1944 volume on "Liberators" and long-range fighters than in 1943. . . . Pres. James Ogsbury of Fairchild Camera told stockholders that the company has had some cancellations but that there is still sufficient volume of unfilled orders on hand to keep the plants busy for "some months."

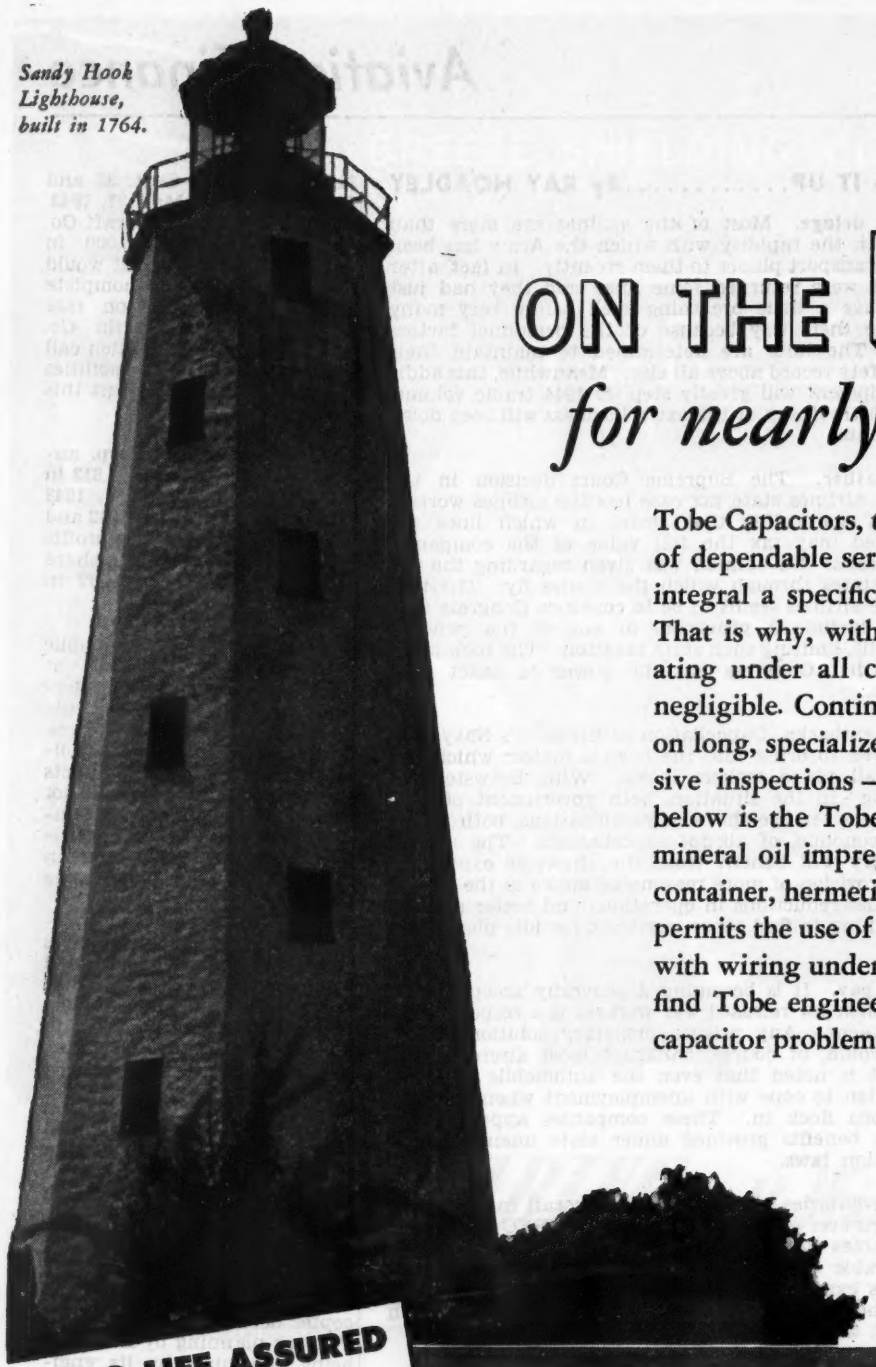
Ex-Cell-O Corp. reports net profit for the quarter ended Feb. 29 of $484,978 or $1.21 a share against $723,476 or $1.81 a share in the like 1943 period.

Future Outlook: Jacobs Aircraft Engine Co. reports that research shows possibilities for wide developments in the helicopter field after the war. . . . Postwar planning by Boeing is being continued by its engineering department and by an independent agency looking to possibility of manufacturing and marketing of other products in addition to aircraft.

Western Air Lines has taken over active operation of Inland Air lines, the CAB having approved the sale of Inland to Western Air.

Airplane Manufacturing & Supply Corp. reports net income of $165,420 or 44c. a share in the year ended Nov. 30, 1943.

United Air Lines will, in five years after the war, be doing a business five times the best prewar year, according to Pres. W. A. Patterson, or $100,000,000 against the $18,000,000 reported for 1941.



Sandy Hook Lighthouse, built in 1764.

ON THE BEAM-
for nearly two centuries

Tobe Capacitors, too, are "on the beam"—giving years of dependable service . . . for, at Tobe, *long life* is as integral a specification as the dimensions themselves. That is why, with millions of Tobe Capacitors operating under all conditions, "returns" are practically negligible. Continuation of this enviable record rests on long, specialized manufacturing experience—intensive inspections—and constant research. Illustrated below is the Tobe OM-Capacitor. This capacitor is a mineral oil impregnated unit in a streamlined drawn container, hermetically sealed. The hold-down bracket permits the use of either inverted or upright terminals, with wiring underneath or on top of chassis. You will find Tobe engineers ready to cooperate on your own capacitor problems. Why not inquire now?

TOBE DEUTSCHMANN CORP. TOBE CANTON · MASSACHUSETTS

LONG LIFE ASSURED

This new separate mounting is stronger and helps prevent leaks caused by breaks in can. This outstanding Tobe design takes the minimum amount of space.

SPECIFICATIONS

OM-CAPACITORS

TYPE	OM-*
RATINGS	.05 to 2.0 mfd. 600 V. D. C. .05 mfd. to 1.0 mfd. 1,000 V. D. C.
STANDARD CAPACITY TOLERANCE	20%**
TEST VOLTAGE	Twice D. C. rating
GROUND TEST	2,500 Volts D. C.
OPERATING TEMPERATURE	-55° F to 185° F
SHUNT RESISTANCE	.05 to 0.1 mfd. 20,000 megohms .25 to 0.5 mfd. 12,000 megohms 1.0 to 2.0 mfd. 12,000 megohms
POWER FACTOR	At 1,000 cycles—.002 to .005
CONTAINER SIZE	Width ⅜", length 1 5/16", height 2¼"
MOUNTING HOLE CENTERS	1½"

MIDGET OM-CAPACITORS

TYPE	OMM-*
RATINGS	.05, .1 and 2 x .05 600 V. D. C. -.05 x .1 1000 V. D. C.
STANDARD CAPACITY TOLERANCE	20%**
GROUND TEST	2,500 V. D. C.
OPERATING TEMPERATURES	-55° F to 185° F
SHUNT RESISTANCE	20,000 megohms
POWER FACTOR	At 1,000 cycles—.0075
CONTAINER SIZE	Width ⅜", length 1 5/16", height 1 11/64"
MOUNTING HOLE CENTERS	1½"

*Data sheets showing complete code number for units having a specific capacitance value and voltage rating available on request. **Other tolerances available.

A SMALL PART IN VICTORY TODAY...A BIG PART IN INDUSTRY TOMORROW

COMDR. ROLAND G. MAYER, former assistant manager at Consolidated Vultee's Fort Worth division, recently was named manager of the plant in an announcement by I. M. Laddon, executive vice-president of the corporation. (Hill & Knowlton photo.)

MRS. MARY S. JACKSON, recently named director of counselling for Consolidated Vultee Aircraft Corp., is the company's first woman executive. The counselling of women employees has been given the status of a full department under Mrs. Jackson's direction.

COL. CLAIR A. PETERSON recently flew an Army "Mustang" from Los Angeles to New York in the record time of 6 hr. 31 min. He is a former United Air Lines pilot on leave with the military services as personal pilot to Gen. Henry H. Arnold.

GRANT C. EHRLICH is president of the newly formed Resin Industries, Santa Barbara, Calif., which will produce synthetic elastimers, including vinyl resin, ethyl cellulose, and similar compounds as well as render engineering and production service.

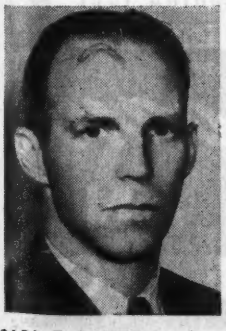
S. PAUL JOHNSTON, former editor of Aviation, one time coordinator of research for the NACA, more recently Washington public relations representative for Curtiss Wright Corp. and author of several aviation books, is presently on active duty with the Navy.

JOHN W. WHITE has been elected president and general manager of the Westinghouse Electric International Co., subsidiary of Westinghouse Elec. & Mfg. Joining the company in 1907, he lived abroad for 18 yr. managing WEI affairs in the Caribbean area, the Far East, and many South American countries. WILLIAM E. KNOX has been elected vice-president of the company. He is the proud holder of the Westinghouse Order of Merit as well as the Chilean Order of Merit, which carries with it the rank of commander. (Blank & Stoller & Pach Bros. photos.)

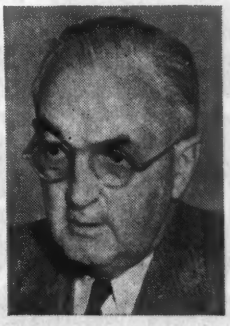
COL. PHILIP J. REILLY, managing director of the Associated Merchandising Corp., was appointed head of a distribution program for The Aviation Corp.'s post-war production of household appliances, planned to supplement their aircraft parts production.

ANDREW "DUKE" REID has been named assistant chief inspector of the aircraft division of the Willys-Overland Co. He has been in the aviation industry for the past 31 yr., and before joining Willys-Overland was field service representative for the Brewster Co.

VICE ADM. AUBREY FITCH was named Deputy Chief of Naval Operations for Air, succeeding Vice Adm. John S. McCain. Former commander of aircraft in South Pacific, Vice Adm. Fitch is credited with having driven the Japanese from the air in that area.



CARL F. BAKER has been appointed chief engineer of Hamilton Standard Propeller Div. of United Aircraft Corp. He will have responsibility for all activities of the engineering department concerned with production, including inspection metallurgy, installation, etc.



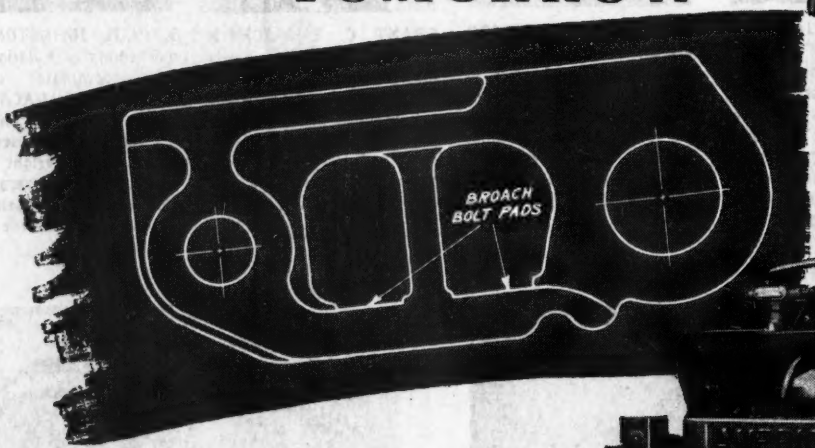
JOHN P. "JACK" DODS, Director of Research and Advertising Manager for Summerill Tubing Co., was appointed director of advertising and sales promotion for the affiliated interests of Columbia Steel & Shafting, and The Edgar T. Ward's Sons Co.

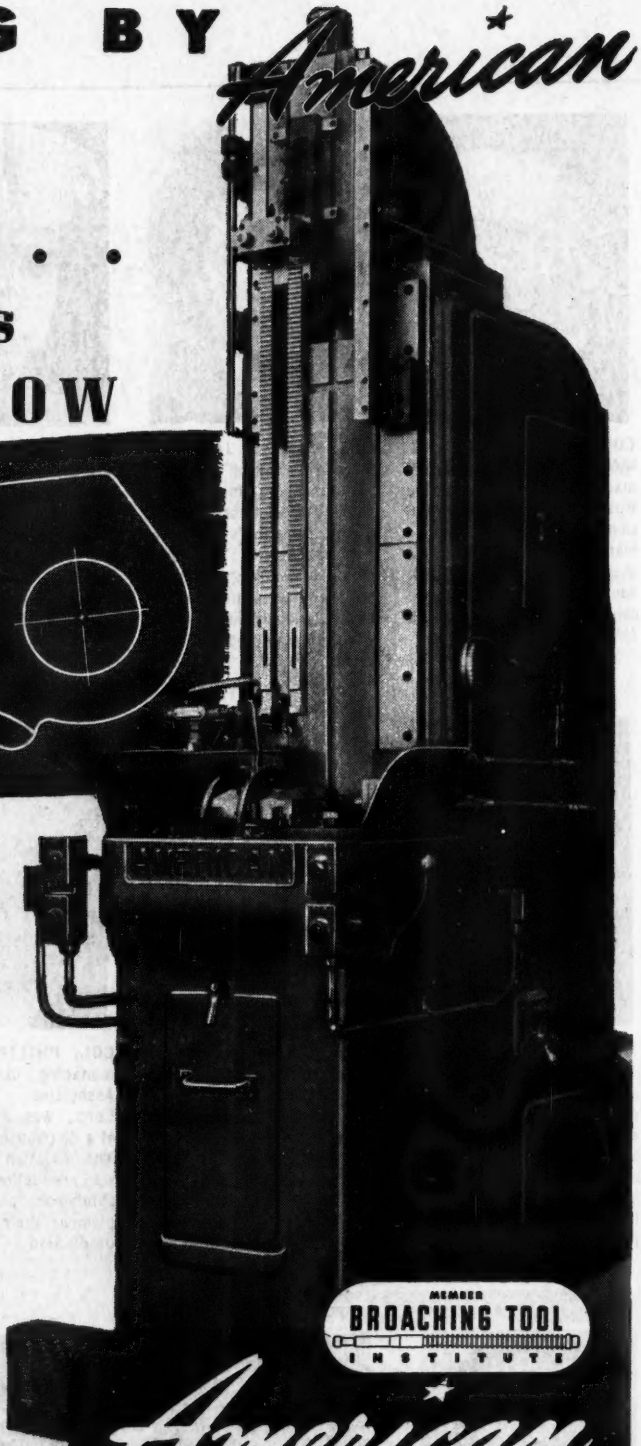
CAPT. L. D. "HAP" ANDERSON has been named chief pilot in charge of all flight officers for Chicago & Southern. He has logged more than 12,000 hr. during his 16 yr. of flying, and until last Dec. 1 he was president of C&S's pilots' council. J. A. YOUNG (center) general manager of the modification center at Memphis, has been named assistant to Bruce E. Braun, v.-p. operations, and will have the maintenance, modification, engine overhaul, engineering, purchasing, stores, and coordination of Army contracts under his supervision. CAPT. REED KNIGHT, former chief pilot, was named superintendent of flying and director of military cargo. He will direct all pilots, first officers, and the company's military cargo operations. (Chicago & Southern News photos.)

BROACHING BY American

PROVEN

on Tanks Today . . .
Ready for Tractors TOMORROW

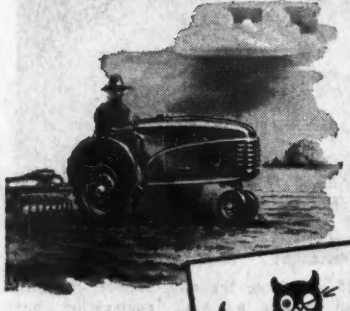




War's demands necessitated an increase in the speed of precision production. Broaching met the challenge successfully. Forward-looking manufacturers will plan to cut costs, use manpower efficiently in peacetime by broaching—the *American* way.

Here is a typical example: Increased output, uniform accuracy, and excellent finish are obtained by broaching the internal bolt pads in tank track connector links. An *American* T-15-36 3-way type machine, provided with a manual positioning device to prevent loading a part of the wrong hand, does the work quickly, economically.

Let *American's* complete broaching service—machines, tools, and engineering—help you in war production or in postwar planning. Phone, wire, or write for complete information.



Enlist the services of an expert broach manufacturer when broaching tools are to be designed. Obtain the benefit of his experience.

MEMBER BROACHING TOOL INSTITUTE

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BROACH AND MACHINE CO.

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DIVISION OF SUNDSTRAND MACHINE TOOL CO.

Side Slips

WITH A SIGH, we recall those halcyon days when the "man at the controls"—whether he tooled a vehicle on land, on sea, or in the air—proudly wore dashing headgear as the badge of his profession. Anyhow, we sadly report the final defilement of that honored tradition. With our very own eyes we recently witnessed the engineer of our crack Westchester commuter train wearing . . . it hurts us to reveal this . . . yes, wearing a straw hat, one of those unbending "sailor" affairs. Then at Wichita the other day we saw a renowned test pilot slip unconcernedly out of a B-29 and—you wouldn't believe it, but his lid was one of those blue-and-white-striped roundhouse engineer's caps.

So our glamorous railroaders are voluntarily back-hatting to crass civilian status, and our intrepid flyers are assuming the relatively plebian toppers of engineers. Seems that the boys of the rocket fraternity—the ones who'll be calling themselves astronauts—are now left in exclusive possession of those grand old aero chapeaux, the well-upholstered helmets. "Fair enough," says the flyer chap who's leaning over our shoulder. "They'll sure need 'em when they start shooting landings on the moon!"

• There's at least one British pilot who's found lend-lease tanglesome in a rather personal sort of way. Lad we're referring to picked up a new fighter job at an East Coast plant, buzzed her off the runway, and headed for a regional modification field to get her camouflaged. But just past New York City his charge developed a bit of engine trouble, so he landed at Port Newark, now Atlantic Overseas Air Service Command base, and there he found ready assistance. "Sure thing, said the AOASC'ers, pausing in their labors of trimming down warplanes for shipment. "We'll fix your engine. Ship'll be all set for you in the morning."

But when he came back next day, the Briton didn't see his plane on the line. He hunted up and down, still couldn't locate it. Finally he checked back at the hangar. "I say," he intoned, "where *is* my aircrawft?" The silence was thick; nobody seemed to know. Then suddenly a call from the apron broke the impasse: "B'geez! *There* it is—trimmed, plastered, an' goin' down th' slip on a barge!" Conclusion: The Briton had to go back to the plant and get a new plane.

• Of course, Ford's public relations department regularly paints us potent pictures of Willow Run's great *Lib* production. However, this story didn't come from Ford's PR; it was told us by an old friend of ours, a scientist at the U. of Mich. Recently he was watching some kids playing in a town near the Run, when a small training plane modestly put-putted by. And he was amazed at the youngsters' reactions. They abruptly stopped their game, craned their necks, and vociferously exulted. "Look at that!" . . . "It's a PT-17!" . . . "Bab-eee!"

Wonderingly, our friend asked, "Why all the excitement?" Whereupon one of the boys crooked a thumb toward Willow Run and began monotoning in Kipling-esque "Boots! Boots! Boots!" style. "B-24's! B-24's!," he muttered. "More B-24's! Still more 24's! I wanna tell you, mister, them B-24's get mighty monotonous."

• Heaven knows we have trouble enough with typographical errors, but one we read in a newspaper the other day seemed just a *little* too prophetic. Reporting on a large aviation company's future plans, the dispatch said, ". . . . this household appliance manufacturing program will supplement the corporation's over-all-aircraft parts production and will badly diversify postwar operations."

• We never thought the science of aeronautics would change the methods of raising babies, but it has. Friend of ours mentioned taking care of his year-old heart-breaker and we asked (naively it now appears) if he was good at changing three-cornered pants. "They're four-cornered now," he replied in a superior tone, "wing area is much greater and boundary layer control is much better."

• Lagging behind formation, the bomber was really taking a beating; fighter planes were ripping in from behind and bullets galore were going out the front through the windshield. Quite naturally, both pilot and co-pilot were pressing hard against their armor plates, wishing to heaven they were midgets. Nodding at the control quadrant out in the middle, the pilot said casually to the co-pilot—over the intercom—"May I have a little more boost, please?" Said the co-pilot,—also over the inter-com, but not so casually—"Brother, if you want more boost, you stick your own damn hand out there."

"Maguire wants everybody to know he's been to one of our bomber bases in Russia."

KEEP POSTED ON

Products and Practices

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ENGINEERING DATA

Aircraft Hydraulic Control.....1

New development to lighten and simplify hydraulic control system for actuation of wing flaps, landing wheels, and other mechanisms of large cargo and transport planes is disclosed in paper entitled *Aircraft Hydraulic Pumps and Related Accessories*, by J. A. Lauck, chief engineer of pump developments, Pesco Products Co., Cleveland, division of Borg-Warner. New device is power package unit weighing 8 lb. which combines an electric pump, pressure relief valve, and pressure switch.

Process Converts Wood.....2

News release from E. I. du Pont & Co., Wilmington, Del., describes new chemical method of changing properties of wood so that it may be used in many new ways, even substituting for steel in certain machinery parts. Wood derivatives such as sawdust, shavings, and paper are reported to lend themselves to the process, also cotton, leather, and farm wastes.

Aluminum Alloys 3

National Smelting Co., Cleveland, offers new booklet, *Red-X Aluminum Alloys*, story of custom-made alloys, giving their composition, properties, and specifications.

Synthetic Rubber 4

Acadia Synthetic Products Div., Western Felt Works, Chicago, has published 70-page spiral-bound book *Synthetic Rubber Data*. Laboratory evaluations of various compounds when exposed to oils, fuels, and solvents are presented, much of this data having been developed from research instigated by problems of aeronautical engineers; also charted are tests of such effects as freeze resistance, hardness, heat, fuel resistance, aging, etc.

Flexible Coupling.....5

Bulletin describing space-saving flexible coupling has been released by Farrel-Birmingham Co., Ansonia, Conn. Couplings are for applications where space limitations make necessary close-coupled connection. Included are engineering details, application diagrams, and tables of sizes, ratings, and dimensions.

Special Purpose Machines.....6

New 76-page *Blue Book for Management, Shop & Production Engineers*, issued by Delta Mfg. Co., Milwaukee, presents case histories of 140 special-purpose machines. The designs employ standard Delta drill press heads and columns and other company tools.

Micro Inch Measurements.....7

How to Measure in Micro Inches deals with fundamentals of precision measurements, showing how principles are applied in control of quality. Photographs show many applications for gage blocks, vernier gages, sine bars, master parallels, flats, etc. Published by Continental Machines, Minneapolis.

Metal Plating on Plastics.....8

In The Metaplast Process and License Plan, Metaplast Co., New York, explains process of metal plating on plastics, gives general properties and information on preparation, lists surfaces that can be "metaplated," and describes activities and operation of the Metaplast Guild.

Carbide Tools in Machining.....9

Carboloy Co., Detroit, offers bulletin *The Machining of Steels on Automatic Screw Machines With Carbide Tools*. Suggestions cover: speeds and feeds, horsepower, roughcuts, cut-off tools, rake angle, tool grinding, coolant, and chatter.

Finish Control 10

New folder on inspection and control of surface finishes offered by George Scherr Co., New York, describes Spencer binocular microscope and illustrates its operation.

Chain Belts 11

Chain Belt Co., Milwaukee has issued new catalog of chain belts for drive and conveyor service. Used in belts is Rex Z-metal, ductile ferrous cast metal with high tensile strength.

Alkaline Copper Plating.....12

Bulletin from United Chromium, New York, describes "Unichrome" alkaline copper plating process, stated to produce lustrous deposits at high speed in a non-cyanide solution.

Low Temperature Welding.....13

New developments in Aircraft Welding describes low temperature welding rods made by Eutectic Welding Alloys Co., New York, designed to give smooth, clean, machinable welds at bonding temperature of alloy.

Aluminum Color Finishes.....14

Bulletin from Mutual Chemical Co. of America, New York, describes process of *Dyeing Chromic Acid Anodized Aluminum* and gives tables showing results obtained with vari-colored dyes.

Removing Metal Coatings.....15

Technical service data sheet on removal of metal coatings such as copper, zinc, lead, cadmium, and magnesium from steel, nickel, chromium, or aluminum, is offered by American Chemical Paint Co., Ambler, Pa.

Steel Ball Manufacture.....16

Making Them Round, booklet describing processes in ball bearing manufacture, has been issued by New Departure Div., General Motors Corp., Bristol, Conn.

Shipping Containers 17

General Box Co., Chicago, offers booklet, *The General Box*, which describes many types of shipping containers, including export boxes.

Packing Engines for Export.....18

Folder descriptive of methods of packing engines for export shipping has been issued by Angier Sales Corp., Framingham, Mass. Photographs illustrate various types of crates and use of company's product, "Brownskin".

Metal Sealing Compound.....19

Ault & Wiborg, Cincinnati, Ohio, has developed a new synthetic resin sealer for impregnation of magnesium, aluminum, and other metal castings. Known as No. 988 magnesium sealing compound—styrene soluble, sealer is described in bulletin.

MACHINERY & ACCESSORIES

Welding and Tool Data.....20

Handbook of engineering data, welding methods, and heat treatment procedures for tool and die steels has been published by C. E. Phillips & Co., Detroit, titled. *Arc Welding in the Maintenance and Construction of Tools and Dies.* Ten types of electrodes are described, and furnished are data on deposit characteristics, physical properties, and special details of application procedure.

Hydraulic Press 21

Watson-Stillman Co., Roselle, N. J., offers bulletin No. 870-A covering a general pur-

AVIATION READER'S SERVICE

JULY 1944

AVIATION, 330 W. 42nd St., New York City

Please send me additional information according to key numbers circled.

INFORMATION TIPS						1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58								
NEW PRODUCTS					59	60	61	62	63	64	65	66	67	68	69	70	71
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107
108	109	110															

NAME..... TITLE.....

FIRM OR AFFILIATION.....

ADDRESS.....

pose hydraulic press suitable for diversified work in the metal forming, ceramic, or plastic industries. There are detailed descriptions of five sizes.

Repairing of Cutting Tools.....22

How to Repair Broken Cutting Tools With Easy-Flo is treatise issued by Handy & Harman, New York.

Electric Chain Hoist.....23

Bulletin No. H. 23 describing new "Handi-Lift" electric chain hoist is offered by Harnishfeger Corp., Milwaukee. Unit is rated at 500 lb.

Sight Flow Indicators.....24

Complete line of "Bull's Eye" sight flow indicators is shown in new catalog 93-B issued by Fischer & Porter Co., Hatboro, Pa.

New Carbide Tools.....25

Many carbide-tipped cutting tools generally classified as special are now listed as standard in new catalog No. 144 issued by Wendt-Sonis Co., Hannibal, Mo. New tools are stated to be specially designed and not adaptations.

On Reamers 26

Catalog from Wetmore Reamer Co., Milwaukee, covers complete line of adjustable, inserted-blade reamers, boring bars, and special tools. Included are data useful to production men and tool engineers.

Ferrule Beading 27

Newly developed ferrule beading machine is described in bulletin offered by Champlain Div., The Fred Goat Co., New York. Machine is mechanical device for attaching aluminum ferrules to flexible shielding conduit.

Compressors, Vacuum Pumps.....28

Ingersoll-Rand Co., New York, announces new catalog of compressors and vacuum pumps in sizes from ½ to 10 hp. shown are dual-pressure portables designed for servicing and repair of aircraft.

Accessories for Lubrication.....29

J. N. Fauver Co., Detroit offer new catalog of installation accessories for lubrication, hydraulic, steam, liquid, and air applications. Couplings, fittings, and hose clamps are shown.

Oxy-Acetylene Handbook 30

The Oxy-Acetylene Handbook, published by Linde Air Products Co., New York, treats range of oxy-acetylene welding and cutting processes in textbook style.

Electrical Circuit Analyzer.....31

Description and specifications of new "Umco" analyzer for aircraft electrical circuits are found in new bulletin issued by United Hydraulic Mfg. Co., Los Angeles. Unit is reported capable of locating and analyzing virtually all electrical and wiring troubles in 75 percent of all American Aircraft.

Electronic Controllers.....32

Bristol Co., Waterbury, Conn., announces bulletin No. B220 describing new line of free-vane electronic controllers for automatically controlling temperature, pressure, liquid level, and humidity. Given are wiring diagrams and principle of operation.

Gage Block Finish.....33

New type of finish for gage blocks stated to hold precision accuracy in blocks over extended period, is described by Fonda Gage Co., New York, in illustrated new bulletin, *Precision in Millionths.*

Collet Chucks 34

Redmer Air Devices Corp., Chicago, announces addition of new sizes to its line of collet chucks which, accordingly, now give a collet capacity up to 1¾ in. Full description is given in bulletin.

New Gage Design.....35

Bulletin from Metrical Laboratories, Ann Arbor, Mich., describes the "Metricator", new gage designed for measurement of slots and thicknesses, using flow of air as measuring medium.

Hydraulic Press Operation.....36

Modern applications of hydraulics to self-contained, high speed production equipment are shown in detail in *Bulletin 4400* from Hydraulic Press Mfg. Co., Mt. Gilead, Ohio. H-P-M closed-circuit system provides regulation of both speed and direction of press ram movements through control of output of pressure-generating pump.

Foundry Ovens 37

"Coremaster" core ovens are described in bulletin just issued by Despatch Oven Co., Minneapolis.

Production Forge Furnaces.....38

Surface combustion production forge furnaces are detailed in bulletin SC-116 offered by Surface Combustion, Toledo, Ohio. Furnaces are equipped for gas, oil, or combination of both.

Surface-Roughness Measurement....39

Second edition of *Practical Surface-Roughness Measurement* is published by Physicists Research Co., Ann Arbor, Mich. Contained is information on importance of surface finishes and on applications of profilometer.

Carbide Tipped Tools.....40

Haynes Stellite Co., Kokomo, Ind., div. of Union Carbide & Carbon Co., offer revised pamphlet, *Stellite Star J Metal Cutting Tools*, giving sizes and information on tool holders and adaptors.

Remote Controls.....41

Designed to meet requirements for aircraft engine controls, "ISOdraulic remote controls now have additional features, as described in new folder issued by Adel Precision Products Corp., Burbank, Calif.

Infra-Red Appliances 42

New principles in infra-red appliances are described in bulletin issued by Infra-Red Engineers & Designers, Cleveland.

Light-Duty Tapping 43

Bulletin LTM-44 describes new light-duty tapping machine made by Detroit Tap & Tool Co., Detroit.

Industrial Jacks 44

Simplex lever, screw, and hydraulic jacks are described in new catalog issued by Templeton, Kenly & Co., Chicago. Jacks from 3- to 100-ton capacity are detailed.

Electronic Publication 45

Allied Radio Corp., Chicago, announces new publication, *Allied Radio and Electronic News*, monthly bulletin of developments in electronic field, for engineers, purchasing agents, and department heads.

Thermocouple Data 46

Wheelco Thermocouple Data Book and Catalog (Bulletin S2-4), issued by Wheelco Instruments Co., Chicago, gives description of products and suggests substitutes for restricted materials. Also offered are temperature conversion tables, millivolt tables, tables on pipe and wire sizes, decimal equivalents, and wire resistances.

Disconnect Electrical Fittings.....47

Bulletin 522 gives engineering details on T&B "Sta-Kon" disconnect way of wiring, system based on application of special tips to ends of wires by pressure tools. Issued by Thomas & Betts Co., Elizabeth, N. J.

Handling Electronic Products.....48

Assembled from many sources, best methods of handling materials that go into electronic and electrical work are given in new booklet, *OK Methods*, issued by American Phenolic Corp., Chicago.

Micro Switches 49

Micro Switches for aircraft are described in detail with uses illustrated in new catalog issued by Micro Switch Co., Freeport, Ill.

Solderless Wire Connections.....50

Illustrated bulletin No. 31, from Aircraft-Marine Products, Harrisburg, Pa., describes complete system of solderless knife-disconnect splicing.

Battery Catalog 51

Aircraft batteries and their specifications are shown in new *Special Lines* catalog issued by Willard Storage Battery Co., Cleveland.

COOK

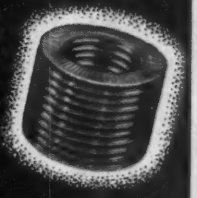
ENGINEERING

Produces

"Extra-ORDINARY"

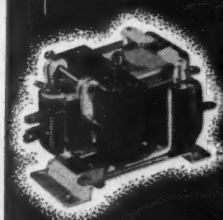
METAL BELLOWS

Metallic bellows that withstand 600 million flexures. Bellows from ¾" O.D. to unlimited diameters and length. Construction that affords a choice of metals from phosphor bronze, copper, stainless steel, Monel, Inconel, beryllium copper or alloy steel.



"Extra-ORDINARY"

RELAYS



Cook relays are built to do the unusual jobs, and are engineered by request to meet "extra-ordinary" requirements. Illustrated is the new Cook Type 594 "Aerolectric" Relay.

"Extra-ORDINARY"

PRESSURE SWITCHES

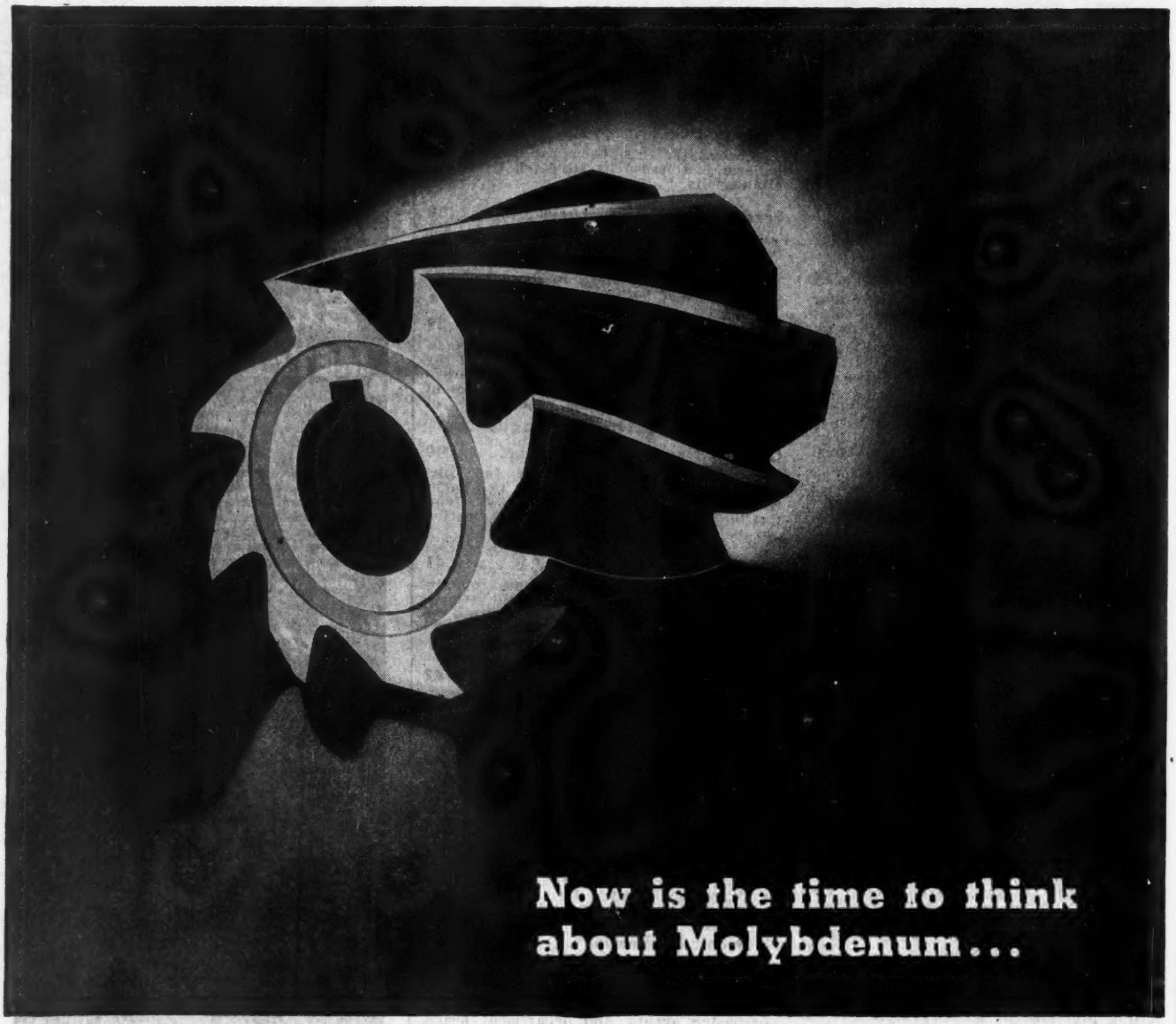
Cook's Family of Pressure Detector Switches cover a complete operating range, from extreme sensitivity requirements at ¼" water column differential to high pressure, hydraulic applications. Illustrated is the new Cook Weather-proof Miniature, for aircraft use.

• Let Cook engineers solve your bellows, relay or pressure switch problems. Cook can give you the right answer QUICKLY.

ARMY E NAVY

COOK ELECTRIC Company

2700 SOUTHPORT AVE. CHICAGO 14, ILL.



It is generally appreciated that the item of perishable tool costs is an important factor in manufacturing accounting. The possibility of savings offered by using molybdenum high speed steels, instead of tungsten types, is therefore worth consideration.

The savings are due first to the lower cost per pound of molybdenum steels, and second to their lower density. The latter results in more tools from an equivalent poundage.

The net savings effected naturally depend on tool performance. It is an established fact that, in a substantial majority of careful comparative tests made in the past, the performance of properly heat-treated molybdenum steels equaled, where it did not better, that of tungsten steels.

A consultation with your supplier should confirm these statements, but it would be a simple matter to check them in your own plant.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

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MOLY

MANAGEMENT & EMPLOYEES

Aircraft Engine Facts.....52

Originally published in Wright weekly newspaper to present engine facts in terms understandable to average employee, Wright Aeronautical Corp., Paterson, N. J., now offers entire series in book titled *Enginology.*

Marketing Chart 53

Basic marketing data in workable form is detailed in *Basic Marketing Chart of the United States* published by Research Co. of America, New York. Nation is divided geographically and figures are given on population, taxes paid, income, life insurance, electrical sales, and many other details.

Business Reports 54

George S. May Co., Chicago, has published following reports on business subjects: *How Waste Reduction Boosts Production, How Business Engineering Benefits Business, How Accountancy and Engineering Share in Effective Tool Control,* and *Preventive Maintenance in the Bottling Industry* (concerned with methods which have common industrial application).

Postwar Cargo Flying.....55

Air Cargoes, booklet issued by Robert Gair Co., New York, contains information for shippers interested in air freight and express.

Express Pamphlet 56

Air Express Now and Tomorrow, by Railway Express Agency discusses air shipping from standpoint of the carrier.

Correction of Workers.....57

Elliott Service Co., New York, announces publication of a working guide for department heads, supervisors, and foreman titled *How to Correct Workers.* Shows how small errors, wrong attitudes, and bad practices may be caught and corrected early and without offense to workers.

Contract Termination 58

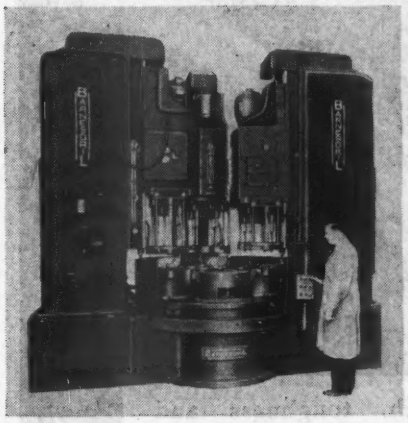
Lyon Metal Products, Aurora, Ill., details its experience and methods in war contract termination procedure, reproducing forms used.

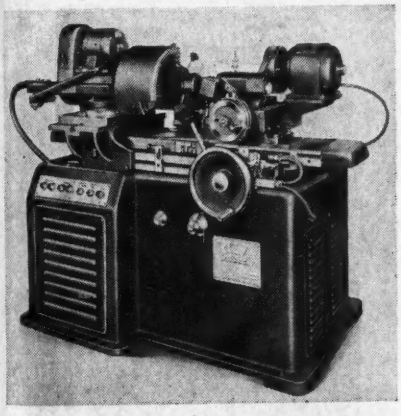
NEW PRODUCTS

Latest Machine Tools

Internal Grinder..... 59

New internal grinder with electric-hydraulic control, high speed table feed, and short stroke, is announced by **Sav-Way Industries,** Detroit. Solenoid operated valves and aircraft type micro-limit switches are designed to provide constant control and reduce time lag. Machine is also equipped for table feed and is available with either manual or electrically controlled power-cross-feed which gives a cross-slide ratchet feed of .0001 in. per tooth, resulting in .0002 in. increase in diameter of hole. Cross-slide hand wheel is graduated in increments of .000125 in. Standard machine is equipped with manually operated wheel-truing mechanism with cam return, and it is also available with semi-automatic diamond wheel dresser. Spindle is driven





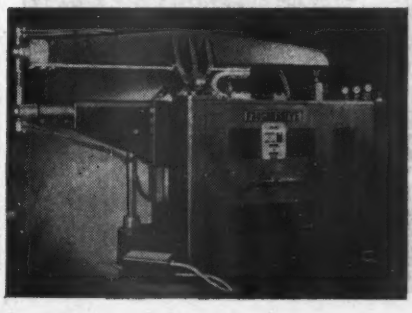
by 3-hp. 3,600-rpm. dynamatically balanced motor, while workhead spindle is driven by ½ hp. 1,140-rpm motor. Workhead spindle speeds of 90, 145, 235, and 365 rpm. are provided through adjustable V-belt drive.—AVIATION, July, '44.

Hydraulic Drilling Units..... 60

Barnes Drill Co., Rockford, Ill., announces completion of new hydraulic production drilling unit which can be arranged for drilling, reaming, facing, boring, counterboring, or tapping operations in any one or combination of horizontal, vertical, or angular positions. Available in three sizes, each is motorized according to requirements. Nos. 10 and 20 have essential parts built-in complete with single motor, driving spindle rotations and hydraulic pump for any automatic hydraulic feed cycle. No. 5 (illustrated) is equipped with separate motor driven hydraulic system. Used vertically as a hydraulic production machine, this unit performs simultaneous drilling, reaming, and counterboring operations. Each unit has a flange support for mounting interchangeable auxiliary heads of any desired number and arrangement of spindles. One standard unit, equipped with an 8-spindle auxiliary head and used horizontally as a self-oiling production machine, is capable of facing and counterboring as many as 8 bosses simultaneously. Hydraulic system of built-in motor on Nos. 10 and 20 is automatically cooled by a fan blower mounted on shaft in front of motor. Chip conveyor removes chips. All controls are located on one side.—AVIATION, June '44.

Spot Welder..... 61

Rocker arm welder, Model "C", for continuous production spot welding of aircraft structural aluminum sections up



IF IT'S A

PLOMB PULLER

Any pulling job is likely to be a mean job — unless you use a Puller you can depend on. Expert mechanics throughout war industries like Plomb Pullers because of the better, safer, longer-lasting service they give.

They choose the other service tools in the complete Plomb Line, too—for the same reasons. From tiny screw drivers to mammoth industrial wrenches, all are built to highest quality standards. Select the ones you need for your war job from the Plomb dealer in your neighborhood. — *Plomb Tool Co., Los Angeles 54, Calif.*

FINE SERVICE TOOLS FOR ALL INDUSTRIES

to ⅛-in. Alclad is announced by **Progressive Welder Co.**, Detroit. Unit is rated at maximum point pressure of 6500 lb. (at 90 lb. factory airline), and deflections are held to a minimum, it is said. Welder will handle fairly large work, throat depth being adjustable from 36 to 42 in. and throat opening from 7½ to 17½ in. In addition to 1-in. working stroke of rocker arm, latter is also provided with retracting stroke which provides 4½-in. clearance between points to permit insertion of flanged work. Controls are provided for three different pressure conditions: Normal, forging, and light for tip dressing. Arms are designed to handle standard electrodes and holders, but refrigerated points may also be used. Electrodes may be mounted vertically or at 22½-deg. angle. Transformers are pancake type with 600 turns, a four position tap switch offering selection of various turn ratios. Floor space of base is 35 x 66 in., height about 5 ft.—**AVIATION, July, '44.**

Wet Belt Grinder 62

Great coolant capacity and rigid construction are reported features of Model AG-8 wet belt grinder made by **Porter-Cable Machine Co.**, Syracuse, N. Y. Unit is equipped with 35-gal. self-contained recirculating pump system. Other features listed are waste clean-out drawer, joggle type switch, high table, and flexible tube as guide for coolant.—**AVIATION, July, '44.**

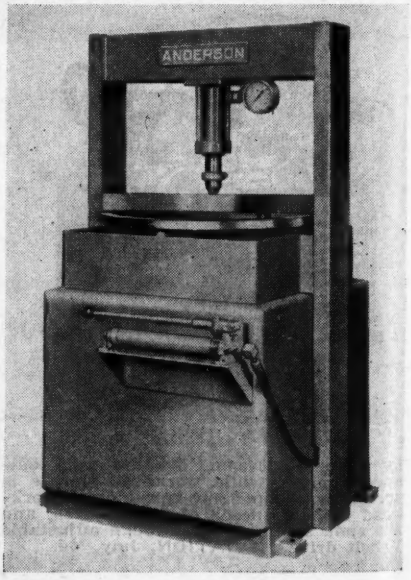
Chip Breaker, Finish Grinder 63

New heavy duty chip breaker and diamond finishing grinder has been designed by **Hammond Machinery Builders**, Kalamazoo, Mich., to meet requirements where large volume of carbide tools are being ground. Features newly designed angle vise to handle all types of box and single point tools up to 2 in., larger if required. Vise has universal adjustments,

and dials are direct reading. Diamond finishing grinding side (at left in illustration) is for use of either 6 or 7-in. dia. cup wheel. Tilting table assembly is moved by screw adjustment. Wheels may be changed without removing table assembly. Grinder is powered by ½-hp. motor, and coolant tank is of 1½-gal. capacity. Total weight is 750 lb.—**AVIATION, July, '44.**

Straightening Press 64

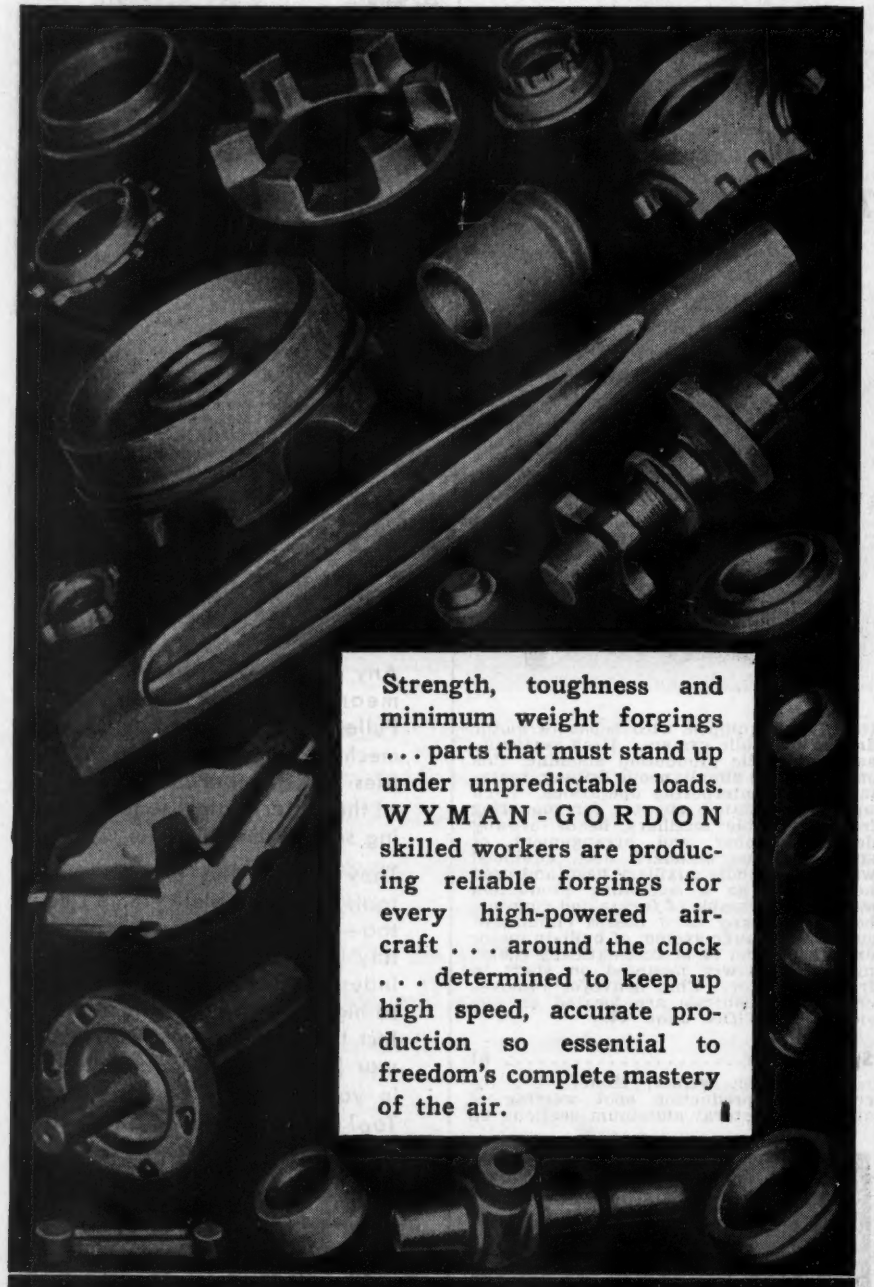
Hydraulic press with 30-in. square table for straightening large gear blanks and metal rings has been designed by **Anderson Bros. Mfg. Co.**, Rockford, Ill. Press illustrated has capacity of 20 tons and is operated by hand hydraulic pump. Similar presses for 10- to 50-ton capacity, with hand or power control, can be furnished. Hydraulic gage, calibrated in pounds, indicates actual pressure on ram.



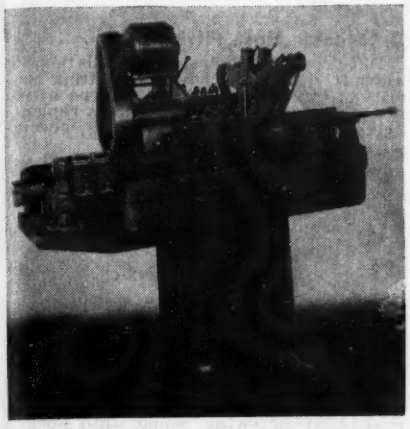
Stroke of ram is 5 in. and maximum vertical opening is 8 in. Floor space is 40x40 in., and net weight is 1,500 lb.—**AVIATION, July, '44.**

Lapping Machine 65

Designed for simultaneous finishing operations on one or several cylindrical surfaces, "Simplex" lapper, it is stated, will also handle concentric and/or eccentric cylindrical portions at same time, as well as such sections as pins of short-


Strength, toughness and minimum weight forgings ... parts that must stand up under unpredictable loads. WYMAN-GORDON skilled workers are producing reliable forgings for every high-powered aircraft ... around the clock ... determined to keep up high speed, accurate production so essential to freedom's complete mastery of the air.
WYMAN-GORDON
Forgings Laboratory Controlled
WORCESTER, MASS. HARVEY, ILL. DETROIT, MICH.

throw cranks on compressors and journals and eccentric members of small camshafts. Machine's capacity is from ½ to 2 in. on diameters with lengths up to 24 in. Uses abrasive coated paper strips



applied to those surfaces on which reduced friction and initial wear is desired. Manufactured by Norton Co., Worcester, Mass.—AVIATION, July, '44.

Shop Equipment & Accessories

Aluminum-Weld Electrode..... 66

Electrode with new coating for use in welding aluminum sheets and castings is announced by Eutectic Welding Alloys Co., New York City. Stated to open a new field for arc welding—salvage and reclamation of aluminum castings—it is said that "EutecTrode 2100" can be used to add metal without completely preheating casting and without overheating metal adjacent to weld. Metal may be added to faulty or improperly machined castings, in overlaying of surfaces improperly cast, filling of low spots, filling faultily drilled holes, and welding casting to sheet, says maker. Available in 5/8, 5/32, and 3/16-in. sizes.—AVIATION, July, '44.

New Shear..... 67

Reported to incorporate best features of shears produced by O'Neil-Irwin Mfg. Co., Minneapolis, since 1940, this new shear No. 3 has precision adjustment for

stopping blade travel, metal stripping guide, and built-in chute which delivers all materials at any speed. Net weight is 150 lb.; max. shearing width, 12 in.; max. shearing capacity full width, 18 gage steel plate (.048 in.)—AVIATION, July, 44.

Shock Absorbing Mallet..... 68

New mallet offered by Taylor Mfg. Co., Milwaukee, is designed for use by air-

NORTON ABRASIVES

METALITE CLOTH SLOTTED DISCS

3/8 to 6 inch diameters

Speed War Jobs

(Upper Illustration)
This 2-Bore Aluminum Throttle Body has a finished bore. There was slippage with hand scrapers. Two 1½" unslotted Metalite discs, grit #60, back to back, were used. This method proved twice as fast as the former hand scraping.

(Lower Illustration)
In this illustration 5" Slotted Discs, grit #100, are used to put 1/16" radius on the edges of these Magnesium 3-Bore Throttle Bodies. This method saved tooling and additional machines. Time for the 3 bores is .68 of a minute.

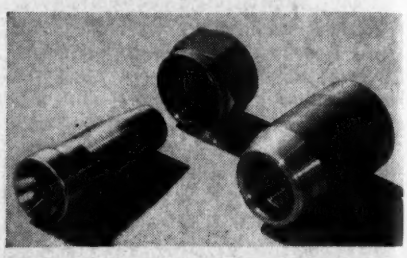
These SLOTTED DISCS, in almost endless sizes and grits, are but one of many Metalite Cloth "Gadgets" ready for instant use on power tools. A few others illustrated below. We'll gladly help you select the proper "Gadgets" for improving a wide variety of your own sanding and finishing operations. Write us.

BEHR-MANNING (DIVISION OF NORTON COMPANY) TROY, N. Y.

craft manufacturers where finely finished surfaces must be protected. Mallets are made in three weights: 12, 18, and 24 oz. However, heads are all same size and no weighted cores are used.—**AVIATION, July, '44.**

Detachable Hose Fitting 69

Developed for hydraulic installations in aircraft, detachable hose male fitting consists of two pieces and swivel type fitting of three pieces, each of which is replaceable individually. Assembly is accom-



plished by screwing nipple into socket. Suitable for AN Standard medium pressure (three braid) and medium high pressure single wire braid hose. Made by **Aeroquip Corp.**, Jackson, Mich.—**AVIATION, July, '44.**

Bronze-Facing of Steel 70

Method of bronze-facing steel pistons involves flame spraying of one material on another. In case of pistons, light steel blanks are sprayed (with special bronze alloy) to desired thickness on bearing surface. This is rough machined in initial production, then given required high finish, with oil grooves. Having extremely fine porosity, sprayed bronze is stated to absorb and retain oil and to become self oiling after short use. Process was developed by **Cleveland Pneumatic Aerol, Div. of Cleveland Pneumatic Tool Co.**, Cleveland.—**AVIATION, July, '44.**

Angle Drills 71

Offered by **Atlas Tool Co.**, Pittsburgh, Pa., is new chrome plated angle drill stated to feature long life through thrust absorption minimizing wear. Incorporated is grease retaining ring designed to prevent drip. Angle plates are equipped with 5/16-24, ¼-28, and 10-32 threaded spindles.—**AVIATION, July, '44.**

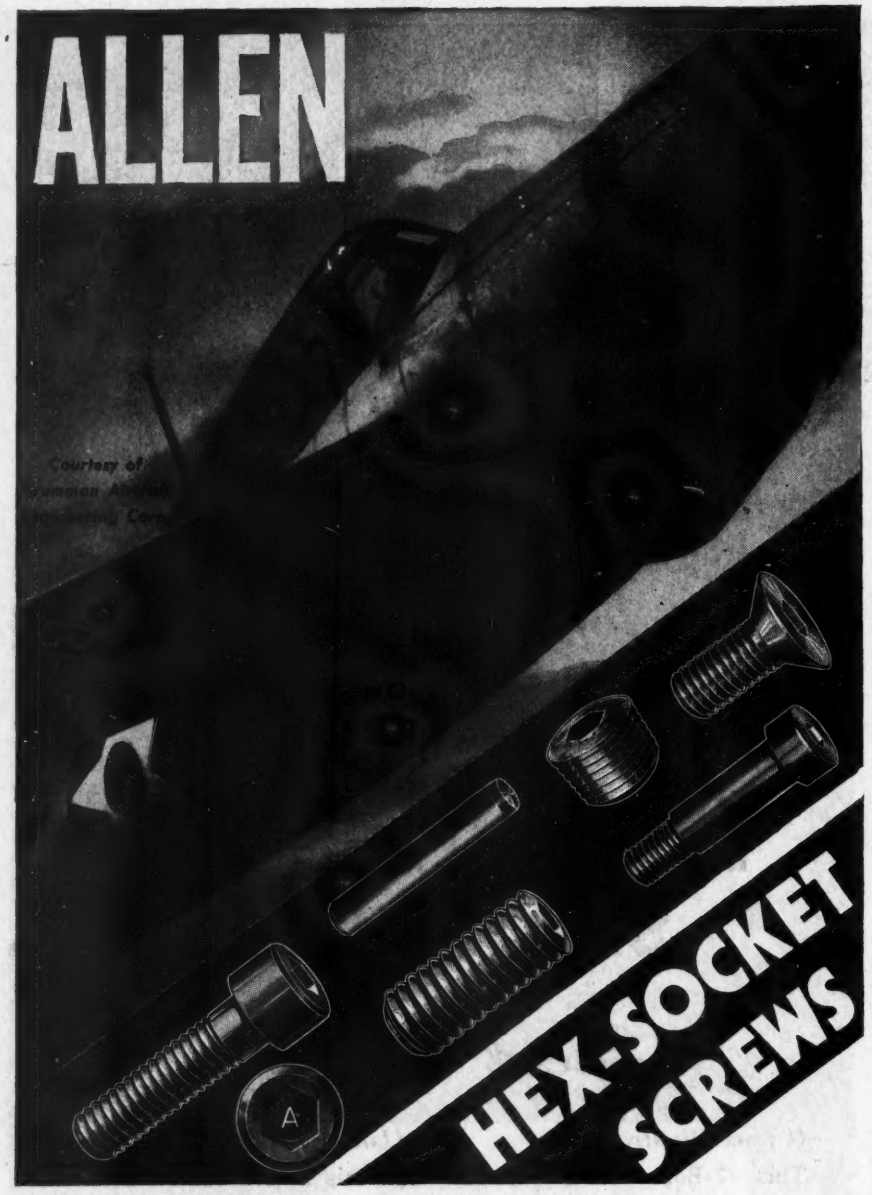
One-Piece Hose Clamp 72

New one-piece clamp for hose has no gears or thumb screws. Clamp is snapped over hose by hand and locked by hand pressure on pliers. Designed for low

pressure connections, it may be had in wide range from 1.2 in. up. Made by **Tinnerman Products**, Cleveland.—**AVIATION, July, '44.**

Asbestos for Air-duct Systems ... 73

New fire-resistant asbestos product for use in air-duct heating and ventilating systems in aircraft has been developed by **United States Rubber Co.**, New York City. It is stated that this product, made of fabric, asbestos, and synthetic coating of resin, can be completely deformed and still return to its original shape.—**AVIATION, July, '44.**



Lives hang by threads aboard aircraft, — the screw-threads that hold together the component parts. And the screws most famous for HOLDING-POWER are those most favored for mechanical assemblies where hollow screws are used in plane or plant.

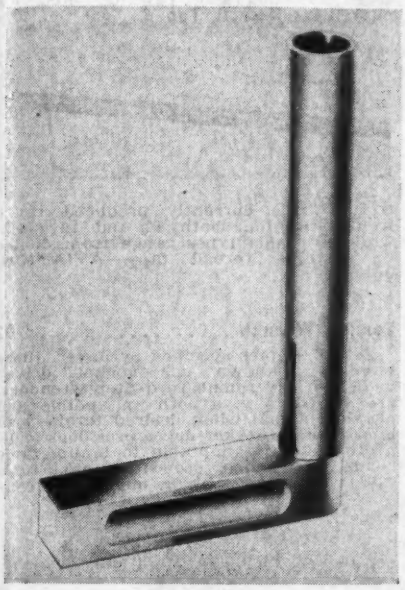
ALLENS have strength for set-ups with weld-like grip, not to be budged by shock-stresses or sustained vibration. Thread tolerances are held to a high Class 3 fit, for a high degree of frictional holding-power... Screws cold-drawn and *"pressur-formd"* of special-analysis ALLENOY steel, heat-treated under scientific controls. Hexagon sockets handily reached with Allen hex Keys in the hardest-to-get-at places. Adapted to high-speed assembling with power drivers.

Allen Hollow Screws and *"Tru-Ground" Dowel Pins supplied only through Industrial Distributors in all centers.*

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

Precision Square 74

New feature of Ellstrom master square, offered by **Dearborn Gage Co.**, Dearborn,



Mich., is cylinder-form upright member screwed to base. As wear develops, fresh new surface can be brought into use by turning cylinder slightly. Squares start at 4-in. size and can be obtained in larger models as desired.—**AVIATION, July, '44.**

Combination Socket Wrench 75

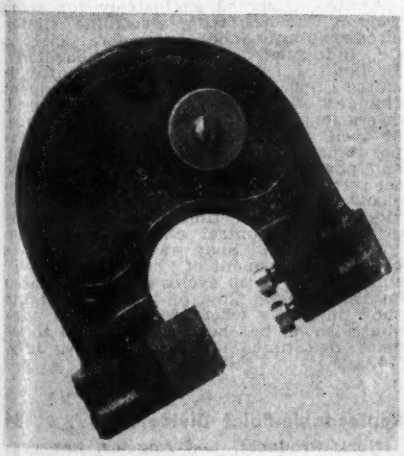
Having same dimensions as a single socket wrench, new "Tesco" multisocket wrench automatically accommodates No. 10 and No. 12 standard, ¼-in. standard and light, and 5/16-in. light hexagon nuts. By pressing over any of three sizes of nuts wrench automatically selects proper nested hexagonal tube, says maker, **The Eastern Specialty Co.**, Philadelphia. Designed for heavy duty service, it provides clearance through barrel for studs up to 5½ in. length. Handle and barrel are insulated.—**AVIATION, July, '44.**

Aluminum Surface Cleaner 76

New method of cleaning aluminum surfaces chemically and metallurgically is announced by **Turco Products**, Los Angeles. Product, named "Vulco-etch" is chemical bath to free surfaces of oxides, corrosive salts, grease, and oil films, laying foundation for sound spot welding.—**AVIATION, July, '44.**

Snap Gages 77

George Scherr Co., New York City, announces four new models of adjustable limit snap gages known as midget type, for checking and inspecting small and



delicate parts. Work from .000 to .760 can be handled.—**AVIATION, July, '44.**

Diamond Hand Hone 78

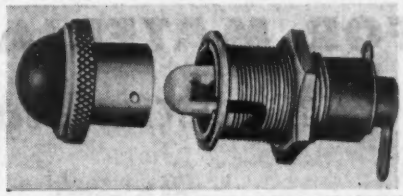
Designed with diamonds set in hard metal bond, hand hone, made by **Diamond Tool Replacements**, Baltimore, provides new method for keeping cutting edges keen. Few strokes quickly sharpen high speed steel and hardest grade of carbide tipped tools, it is stated. Made in three grit sizes—coarse, 100 grit; medium, 220 grit; and fine, 320 grit. Hone is approximately 4-in. long.—**AVIATION, July, '44.**

Hand Model Infra-Red Lamp 79

Stated to be capable of developing temperature in 1,000-deg.-F. range, new tool for quick heating is announced by **Fostoria Pressed Steel Co.**, Fostoria, Ohio. Suggested uses: Melting or flowing grease, pitch, oils, syrups; preheating materials prior to shearing or stamping; rapid drying of liquid coats; touch-up paint finishing, etc.—**AVIATION, July, '44.**

Indicating Light 80

Graybar Electric Co., New York City, distributor for H. R. Kirkland Co., Morristown, N. J., announces new indicating light with bayonet-locked lens cap. Unit,



for use with T 3¼-type single contact bayonet lamp bulb, embodies new design of lamp socket to provide direct connection from shell and center contact pin to terminal spades.—**AVIATION, July, '44.**

• Alert aviation procurement men have discovered that a single call to Graybar gets many aviation electrical needs faster, and on one order. It automatically puts at their service a network of more than 80 warehouses all over the Unitd States, stocked with the superior aviation electrical products of over 200 manufacturers.

They have learned that items often unobtainable anywhere else may be secured through Graybar. This fast, efficient, all-inclusive service costs no more than buying from many smaller, scattered suppliers. Frequently it costs less.

There is a local Graybar Man who will make your business his personal responsibility. Call him today.

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GraybaR QUALITY 75 YEARS OF Electrical Distribution

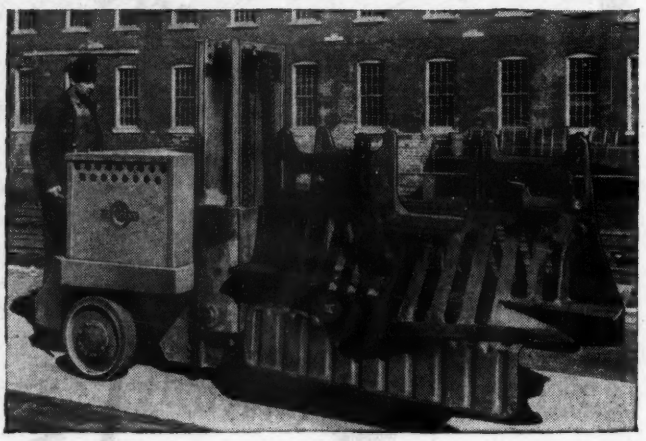
"Air Transport" Speed

FOR MATERIALS HANDLING

with CRESCENT Electric Industrial Trucks

Crescent NA—Aviation leaders pick the Crescent NA because it's the super-utility truck. The one shown is fitted out as a "traveling tool room" at Pratt & Whitney Aircraft, East Hartford, Conn. The large platform area of the NA is adaptable to bulky loads, dump bodies, cranes and other auxiliaries.

Crescent NCRE—This Crescent model, in use at Ross-Meehan Foundries, Chattanooga, Tenn., offers the versatility required in many operations. A self-loading unit, it provides both high and low lifting, tiering and can also be used for trailing loads.



NEW CRESCENT CATALOG — FREE!

Here's the *new*, 24-page Crescent Catalog—yours for the asking. Shows large size illustrations of all Crescent models now being manufactured under WPB Limitation Orders L-112 and L-112a. Describes each model and its particular use. Contains complete specifications and engineering drawings. Write today for this valuable data book on electric industrial trucks—*it's free!*

Look around the factories, warehouses and loading platforms of America's big aviation plants. Watch the trucks go by that speed materials and parts at the stepped-up pace which aviation production demands. You'll see the Crescent emblem again and again. You'll notice that the models pictured are favorites. They're chosen for good reasons . . . and the captions tell why.

CRESCENT TRUCK COMPANY, 1120 Willow St., Lebanon, Pa.

Crescent ELECTRIC TRUCKS and TRACTORS

Industrial Truck and Tractor Specialists for More Than 25 Years

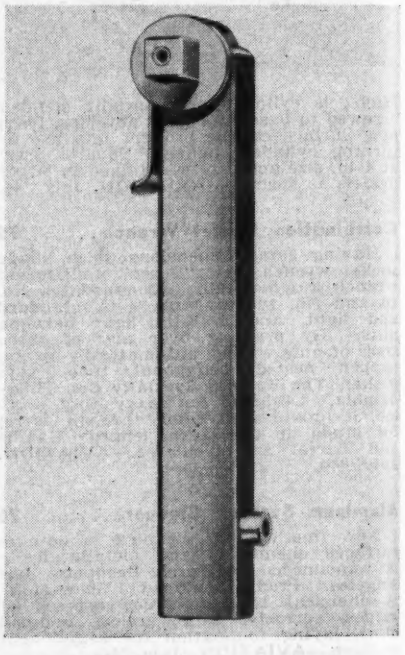
Aircraft-Fitting Thread Taps 81

Special Acme multiple taps for threading quickly-removable type aircraft fittings for fastening cowling, etc., are offered by **Detroit Tap & Tool Co.**, De-

troit. Taps currently produced range from 1-in. dia., both 10 and 12 pitch, while available types range from double to sextuple thread taps.—**AVIATION, July, '44.**

Torque Wrench 82

Set at torques specified by buyer, these wrenches, known as "socket drive" models of Livermont Torq-Stop wrenches, are stated to give both an audible and physical signal when desired torque load is reached. Socket-drive uses lock connection and is adaptable to innumerable heads, extensions, crowsfeet, etc., it is said. Drive or working member is con-



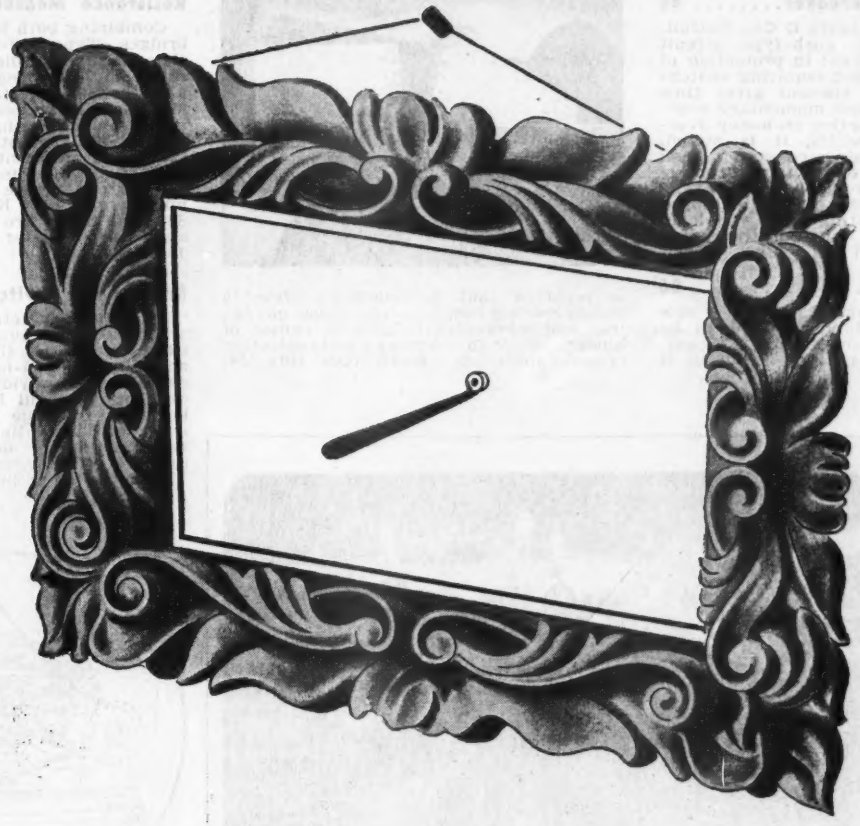
centric with rocker-pin. Settings are available on order at from 8 to 750 in. lb. Maker is Richmont, Inc., Los Angeles, Calif.—**AVIATION, July, '44.**

Seam Welding Control..... 83

Control designed exclusively for seam welding, incorporating electronic timing circuit, is announced by **General Electric Co., Industrial Control Div.**, Schenectady. Designated Type CR7503-B110, control is suited for operations where frequent changes of timing pattern are required. Operating on 230/460/575v., single-phase, 60-cycle power supply, it consists of timing panel, firing and heat control panel, and power panel, each of which can be separately disconnected and removed. An electronic circuit is designated to provide accuracy of timing pattern. Calibrated heat control dial is located on compact panel Snap switches for independent adjustment of "heat" and "cool" time from 1 to 30 cycles are also located on this panel. Row of indicating lights show instantly when water flow is adequate, power has been applied, and time-delay has timed out.—**AVIATION, July, '44.**

Replaceable-Point Dividers 84

Nork Products, Los Angeles, has produced new toolmaker's dividers with replaceable steel points to maintain, preserve accuracy and original length of dividers.—**AVIATION, July, '44.**



Portrait of an Ex-Problem

● At the start of the war our tremendous plane program called for millions of instruments which required a type of ball bearing *not then made in this country.* It was little larger than the head of a pin. It used steel balls so small that it took 111,111 to make a pound!

New Departure took on this problem and in the space of ten weeks had developed the process, built the special machinery and started producing these miniature pivot ball bearings. Now they are standard equipment in Artificial Horizons, Turn and Bank Indicators and Fuel and Manifold Pressure Gauges.

Each tiny ball bearing is complete with race, balls, separator and a retaining shield—as finely built and precisely made as *any* New Departure product.

Each is inspected, gauged, assembled, tested and packed without being touched by human hands—hospital clean and free from any hint of rust, lint or other foreign matter.

This is just another example of a new departure by New Departure—an organization with vast resources for research and a reputation for getting things done even under the most difficult conditions.

New Departure, Division of General Motors Corporation, Bristol, Connecticut. Principal Sales Offices in Los Angeles, Chicago and Detroit.

Nothing Rolls Like a Ball

NEW DEPARTURE

BALL BEARINGS

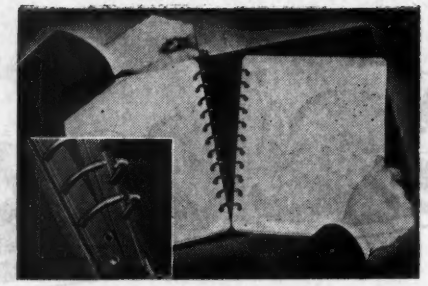
3250

Push-Type Circuit Breaker..... 85

For aircraft use, **Square D Co.**, Detroit, offers new line of push-type circuit breakers for employment in protection of low voltage circuits not requiring switching. Bimetallic trip element gives time limit protection against momentary overloads as well as protection on heavy overloads and short circuits, it is stated. After tripping it is only necessary to push re-set button down to its farthest position. Class 9310 circuit breaker, available in sizes 5 to 50 amp., is equipped with luminous indicating rings visible in darkness and with red indicating ring for daylight.—**AVIATION, July, '44.**

Plastic Binder..... 86

Heinn Co., Milwaukee, announces new plastic "ring-post" binder stated to be lighter and stronger than metal. A combination of ring and post construction, it



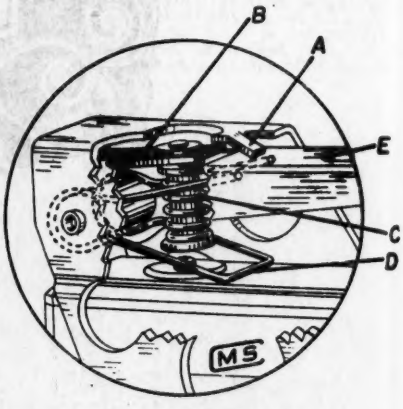
is reported that arrangement prevents sheets tearing out, simplifies sheet changing, and eliminates bulging at center of binder. Made in colors and wide selection of cover materials.—**AVIATION, July, '44.**

Resistance Measurer..... 87

Combining both Kelvin and Wheatstone bridges, Type 638-2 bridge provides resistance measuring instrument having range to 11.11 megohms in single, portable instrument, states maker, **Shallcross Mfg. Co.**, Collingdale, Pa. Low resistance measurements using Kelvin range utilize current and potential terminals to eliminate lead and contact resistance. Rheostat is variable in steps of 1 ohm for Wheatstone bridge measurements and 1 micro-ohm for Kelvin measurements. Separate keys are provided for battery and galvanometer circuit.—**AVIATION, July, '44.**

Bracket for Switches..... 88

Adjustable actuator bracket for switches is announced by **Micro Switch Corp.**, Rockford, Ill. It is described as retaining sealed-in features of basic switch while providing tabs on steel actuator bracket and lever arm which may be bent to change mechanical characteristics of unit. Referring to sketch, by bending tab "A" downward, lever mechanism is held nearer to operating plunger. The more tab is bent, the less pretravel



Lever arm is returned to free position after each operation by spring "D". Operating point of combination is lowered or raised by bending tab "B" up or down. This tab is part of steel lever arm "B" and carries the overtravel spring mechanism "C", which consists of a spring which is pre-loaded above operating point of unit so that it compresses only after switch operates. Motion of actuators' mechanism is carried by lever "E".—**AVIATION, July, '44.**

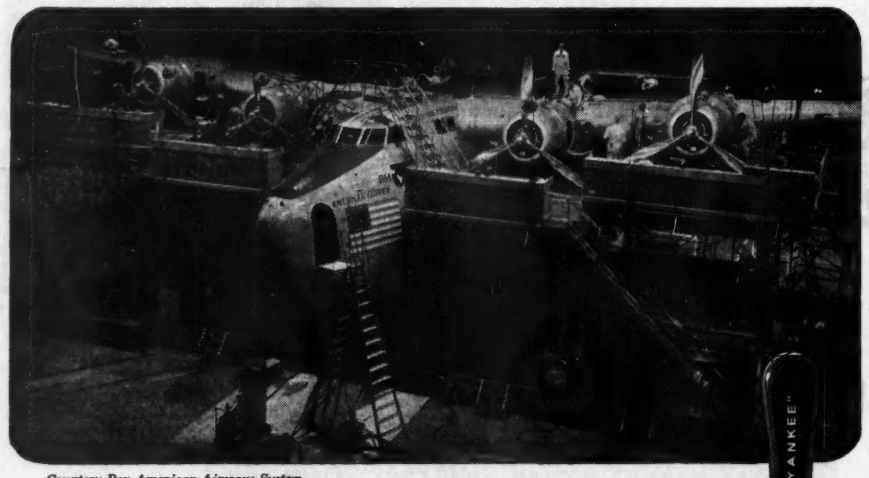
Micrometer Grinding Gage..... 89

Distributed by **Clawson & Bals**, Chicago, the Stuart micromatic visual grinding gage is for application while machine is in operation. Dial indicator guides operator as work is ground to size. Unit, it is stated, has no gears, levers, or angles. Dial is actuated by direct parallel thrust. Made in two models, gage has ranges of ⅛ to 1¼ in. and ⅝ to 2½ in. Additional calipers for larger model provide ranges 2 to 5 in. and 5 to 8 in. —**AVIATION, July, '44.**

Quick Access Fastener..... 90

"M-Loc", new type of quick access fastener for aircraft use, is made by **Simmons Aerocessories**, Long Island City, N. Y. It lies flush with exterior surface, and finger pressure on plate opens door. Made of light stampings, fastener has angle bent in tongue to by-pass reinforcing flange around door opening.—**AVIATION, July, '44.**

(*Continued on page 249*)



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SPEED SERVICING!

Turn-around servicing of a Pan American Airways Clipper Ship is accomplished in 48 hours or less by a ground crew of 186 mechanics and inspectors . . . and "Yankee" Fine Mechanics' Tools help to speed and simplify this vital job. Designed to save time, trouble, and money, their inbuilt ingenuity is lengthening man-hours on the home front; their simplicity, strength, and compactness are upholding more than half a century's reputation for dependability. . . . Provide priority ratings whenever possible. Order from your industrial supply distributor, or write to us — Dept. AV-744.

"YANKEE" SPIRAL SCREW DRIVER No: 130A

"YANKEE" TOOLS

make good mechanics better

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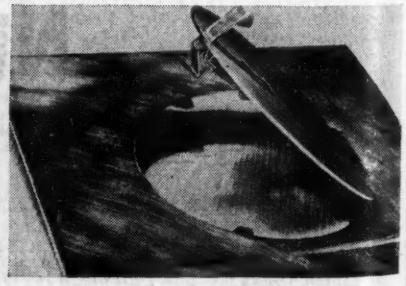
Established 1880



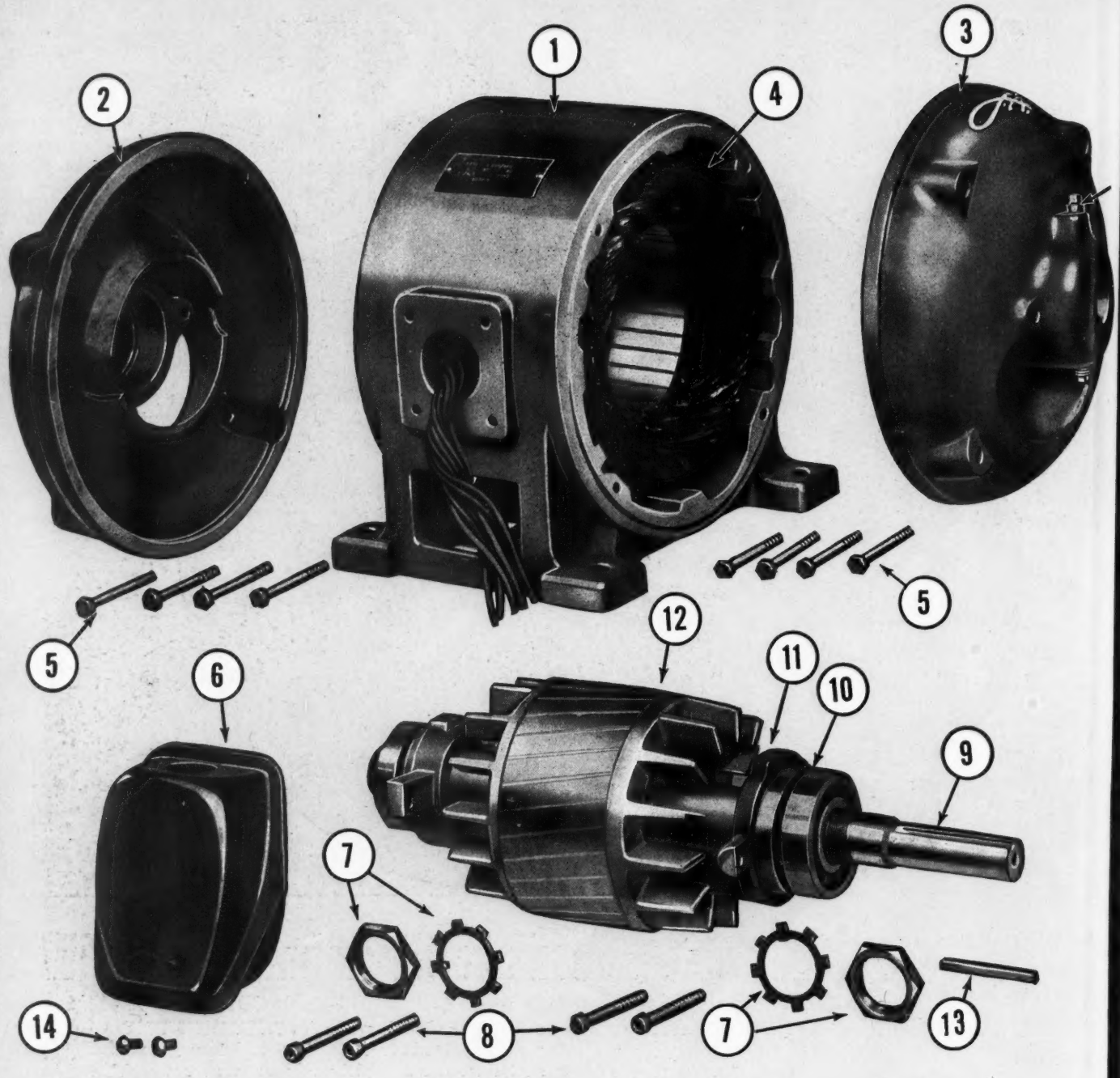
TYPE OG
LOUIS ALLIS
OPEN "PROTECTED" MOTORS
Frame 225 Illustrated

Available Now — A Complete Line

Type OG Louis Allis motors have given a splended account of themselves in the war program for over two years—they are not a "new" line—They have been tried and proven in the most exacting and critical work of the present war effort.

These motors are now available in a complete line—in AC they are available from ½ to 500 HP and in DC from ¾ to 200 HP.

THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.



Simple, Sturdy, Precision Construction Throughout.

Every part of the Louis Allis Type OG open "protected" motors are carefully engineered and precision built to assure long life of dependable service on the tough jobs.

Fourteen points of in-built quality construction are pointed out in the above disassembled view. Upon request a copy of new fully descriptive bulletin will be sent.

THE LOUIS ALLIS CO., MILWAUKEE 7, WIS.

"Boilable" Plastic..... 91

Announced by Monsanto Chemical Co., St. Louis, Mo., is Cerex, new plastic which, it is stated "can be boiled or sterilized and still retain strength and shape." Present supply is reported going into such war products as radar, radio equipment, and other military electronic items where light weight, suitable electric insulating properties, and heat-resistance characteristics are required. Employment

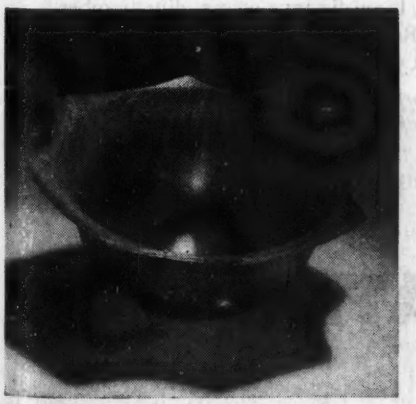
of the product in making aircraft instruments is noted by the company and, as other possible aircraft-part applications, tubing, pulleys, and decorative parts are listed along with general items which must withstand severe temperature conditions. Product is described as a thermoplastic readily molded in standard molding machines; it need not be plasticized and requires no filler; it can be made transparent but has light amber tint; and it is reported to have good resistance to low temperatures as well as to high (where ASTM heat distortion point is put at 220 deg. F.). Further details reported: Flexural strength stated to run about 13,000 lb. per square inch; water absorption gain on ASTM test is 0.3 percent; dielectric strength more than 500 v. per mil; and rating as "slow burning" in flamability tests. Accompanying photo shows of boiling-water immersion test on two plastic radio parts of identical size and shape. Black part right, made of company's product, is seen to have withstood test.—AVIATION, July, '44

Portable Lighting Unit..... 92

Armored portable lighting unit made by Hoffman Co., York, Pa., has convenient handle and large hook. Light globe is aluminum finished with one side plain and clear for concentration of light. Wire guard is made from flat, die-cut sheet steel. Units, using 40 w., 110 v. globe, are available with any length of cord.—AVIATION, July, '44.

Post-Forming Plastic..... 93

"Panelyte" grade 906 is a new post-forming material supplied as a fully cured laminated thermosetting sheet which can be stamped, bent, and drawn in process similar to that used in metal stamping. It is stated that processing is simplified because molds of Kirksite,



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IT'S AIRCRAFT
"Tailor Made" NUTS
Vital Precision equipment such as the Lord RL-25 Dynafocal assembly for Wright R-2600 Radial Aircraft engines demand the finest precision made nuts on the market. That is why Aircraft "Tailor Made" nuts are used.
These assemblies must withstand the unbalanced forces produced by these engines and Aircraft "Tailor Made" nuts have the very important role of keeping assemblies tightly held together at all times under every conceivable condition.
Perhaps you have a need for precision made nuts; if so, send us your blueprints; we will be only too glad to quote prices.
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When a Thunderbolt strikes . . . anything can happen

A THUNDERBOLT roars over the Channel. Calais coming up! An ack-ack gun barks in German from a flak tower. But not for long. Eight 50-caliber machine guns ram hot steel down its throat.

Work to be done upstairs? A flight of Thunderbolts swoops down from high heaven to scatter a cloud of ME's harrying Fortresses on bombing runs over Berlin.

Work to be done on the "deck"? Two earth-quaking bombs slip from beneath a diving Thunderbolt's wings at tree-top level. A bridge blows up . . . and with it the last chance of Nazi reserves to reach the invasion front.

Flown by the finest pilots in the world, the Thunderbolt comes alive. When it strikes, high or low, anything can happen. Guided by skilled hands, it's a fighter that *does everything*. And when hundreds of them strike, everything *does* happen.

The newest Republic P-47 Thunderbolt, with bubble canopy, gives a pilot around-the-clock vision. With hundreds more "emergency" horsepower, he makes and breaks contact with the enemy at will. New propellers add 400 feet per minute to his climb. With a doubled radius of action, the protection of the Thunderbolt's devastating fire power permits heavy bombers a deeper penetration into enemy territory.

Stratosphere fighter, long distance escort, dive bomber, ground strafer—the Republic P-47 Thunderbolt is a busy plane these invasion days.

Republic Aviation Corporation, Farmingdale, Long Island, New York, and *Evansville, Indiana.*

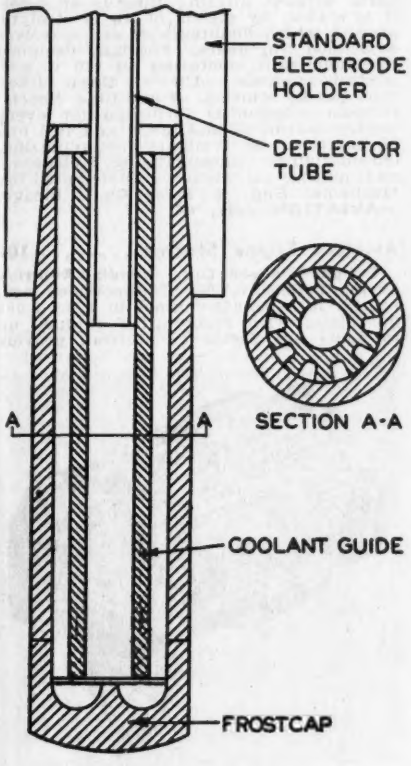
Republic *firsts* in war point to *firsts* in peace

REPUBLIC AVIATION
CORPORATION
Specialists in High-speed, High-altitude Aircraft

cast phenolic, laminated phenolic, or wood may be used. In this process, material, not mold, is heated. High pressures are not required, it being reported that small air cylinders are suitable and in some cases hand presses will suffice. Developed by **Panelyte Div. of St. Regis Paper Co.**,—AVIATION, July, '44.

Self-Adapting Electrode..... 94

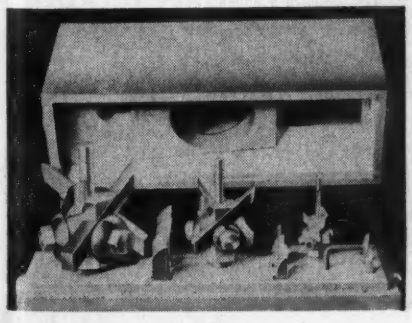
"Frostpoint" spot welding electrode self-adapting for use with standard electrode holders, thus eliminating need for adaptors, is announced by **Frostrode Products**, Detroit. Retaining other features of standard "Frostrode", new electrode is stated to be interchangeable



with conventional electrodes. When electrode is inserted in standard holder, deflector tube is engaged by full-length coolant guide providing metered flow of coolant through internally fined "Frostcap". Return flow is through parallel passages. Available in ⅝- and ⅞-in. o.d. and any standard length.—AVIATION, July, '44.

Adjustable Hole Cutters..... 95

New set of adjustable hole cutters to cut all diameters from ⅝ in. to 3½ in. is announced by **Robt. H. Clark Co.**, Beverly Hills, Calif. These cutters—with straight shanks for use as hand tools, in portable electric and pneumatic drills, or in light drill presses—are stated to produce clean holes requiring no grinding, reaming, or filing. They are also said to be suitable for use in lathes and other spindle-type machines. Consist of straight shank on hexagon body, into which are set three high-speed steel blades at 120-deg. intervals. Largest of three tools has capacity ranging from thin sheets to ⅝ in. thick (1¼ in. where work can be reversed). It is reported possible to cut holes in curved or irregular surfaces, such as pipe or tubing. Smallest cutter has ⅜-in. straight shank, cuts holes ⅝ in. to 1¼ in., equipped with ¼-in. drill pilot. Second size has ½-in. straight shank and is for cutting all diameters between 1 in. and 2½ in. Largest cutter has ½-in. shank or No. 2 Morse Taper and covers all diameters between 2 in. and 3½ in. Other sizes up to 10 in. and thickness capacities to 2 in. are available.—AVIATION, July, '44.



Electronic D.C. Motor Drives..... 96

Line of adjustable-speed electronic motor drives to provide d.c. performance from a.c. power without requiring special motors, is announced by **Weltronic Co.**, Grand River, Mich. Self contained package units are applicable to any machine driven by d.c. shunt motor. Electronic rectifier tubes are employed for conversion, each circuit being individually controlled through other electronic tubes for speed adjustment and current regulation. Full field strength of motor and limited armature current is utilized in starting so that maximum torque may be had without causing excessive power line surges, and speed may be varied without sacrificing torque, it is said. Stepless control of motor speed is obtained by setting a dial. Dynamic braking, dual-control stations, limit switches, or sequence and time controls may be used with units, which may be wall- or floor-mounted, and external transformers are not required. Capacities: From ½ to 3 hp. single-phase and 5 to 10 hp. three-phase (other sizes or special designs for specific applications). Standard voltages are 220/440 at 60 cycles, 550 v., and 25 or 50 cycle machines may be had. —AVIATION, July '44.

Precision

HYDRAULIC TESTING MACHINES

Pendulum load indication is more accurate and dependable because it operates on the natural laws of gravitation. This principle of operation is not affected by temperature changes or subject to metal fatigue. .

. . . . have repeatedly demonstrated the practical truth in the words, "One Test is Worth a Thousand Expert Opinions." Because they have simplified the science of testing the physical properties of materials they are widely used throughout the wartime industries today. Here Riehle Testing Machines "ferret out" material weaknesses and defects; avoid failures before they occur. This technique of progressive testing on the production line and in research laboratories saves valuable machine and man-hours. Write for descriptive literature and quotations.

ARMY E NAVY

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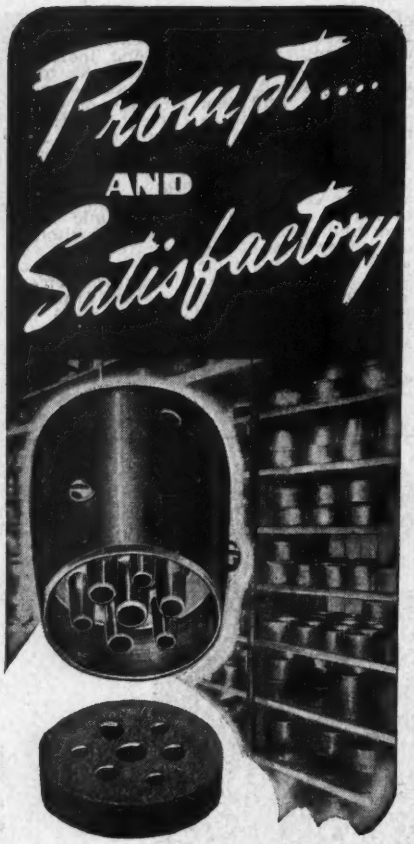

IT IS gratifying to obtain prompt shipment of materials and parts! Even more so, if they exactly suit your purpose. This double achievement is routine occurrence at plants where Booth "prescription" felts — precision die-cut to specifications — are overcoming critical material shortages. Aircraft and other vital war industries thus bypass many a production problem!

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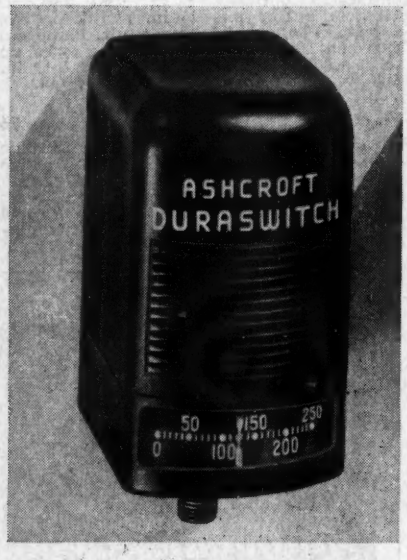
2070

Booth
TRADE MARK
PRECISION CUT FELT PARTS

Switch Combination..... 97

New Duraswitch unit is available combined with Ashcroft gage. Gage has slide rule dial for accurate adjustment of switch to control point. Type illustrated (series E-100) is for pressure only, while models in series E-200 are for both



pressure and temperature applications, as a pressure control and pressure gage combination, or temperature control and thermometer combination, in single or duplex types. Made by Electro Mechanical Div., Manning, Maxwell & Moore, Bridgeport, Conn.—AVIATION, July, '44.

Oil Separator Filter..... 98

New oil separator filter for ventilating systems, made by Air-Maze Corp., Cleveland, is designed to remove oil, kerosene, etc., entrained in air as well as dust and dirt. Unit consists of permanent viscous-impingement filter and a removable oil collecting media to trap liquid particles.—AVIATION, July, '44.

Parts-Cleaning Booth..... 99

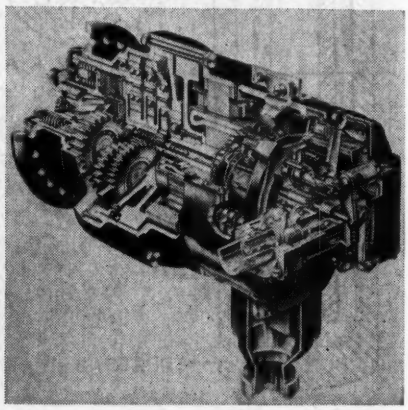
A small parts cleaning booth, designed to meet needs of aviation manufacturing and maintenance shops, is announced by Tivit Products Co., Los Angeles, Calif., and is available in three sizes: 15 in. deep, 20 in. wide, and 20 in. high; 20 in. deep, 30 in. wide, and 30 in. high; and 24 in. x 36 in. x 66 in., the latter being a floor model on 30 in. legs and equipped with a ¼-hp. electric motor, pump, filter, and exhaust fan. A tank on one side of booth contains a penetrating solution which liquifies or loosens stubborn deposits, such as burned on oil, heavy dried grease, and carbon. A wire basket facilitates handling of parts. Spray gun is sturdy, simple to operate, and positive in action. Booth drains into a sump where used solvent is collected for re-use. At rear of booth a vent provides a suitable place for installation of an exhaust fan (if one is required), for two smaller models.—AVIATION, July, '44.

For Removing Broken Drills..... 100

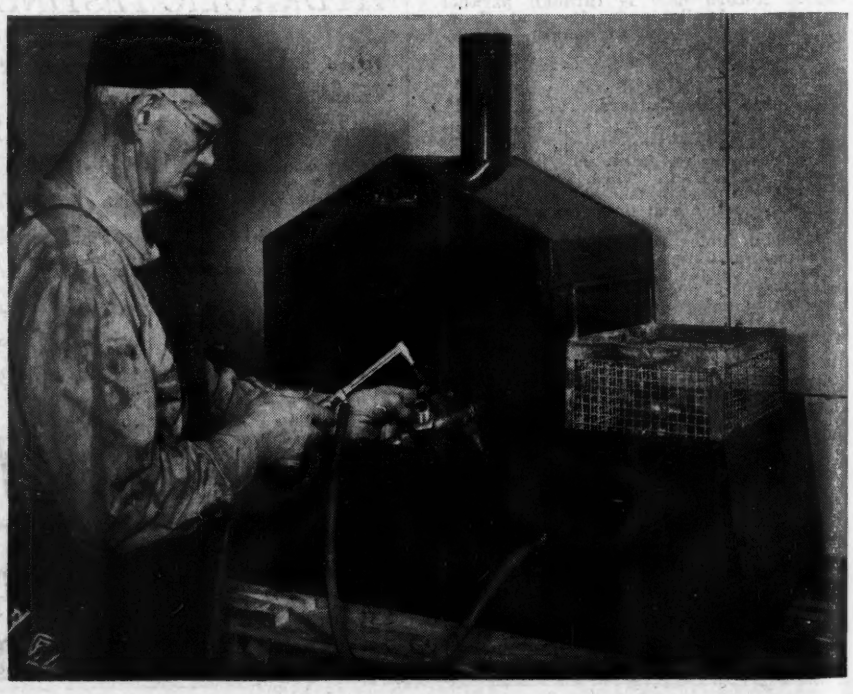
Broken drills and taps are removed from nonferrous castings and machined parts without altering threads or holes, it is stated, by means of an electrolytic process which disintegrates and dissolves embedded fragments. Specially designed electronic unit, operating on 110 v. a.c., controls process. Up to three dozen taps can be removed at one time. Special formula solution is furnished for every nonferrous metal and alloy, and full line of solutions is available for anodizing, chromatizing, phosphatizing, cleaning, and plating all metals. Distributed by Mechemel Eng. & Sales Co., Chicago. —AVIATION, July, '44.

Aviation Engine Starter..... 101

Eclipse-Pioneer Div., Bendix Aviation Corp., Teterboro, N. J. announces new starter for aircraft engines in 1,200-2,500 hp. class, with reserve for engines up to 3,000 hp. Series 48 starters provide



four methods of cranking: (1) Combination inertia and direct-cranking for normal operation; (2) direct cranking alone for warm engine starting; (3) inertia



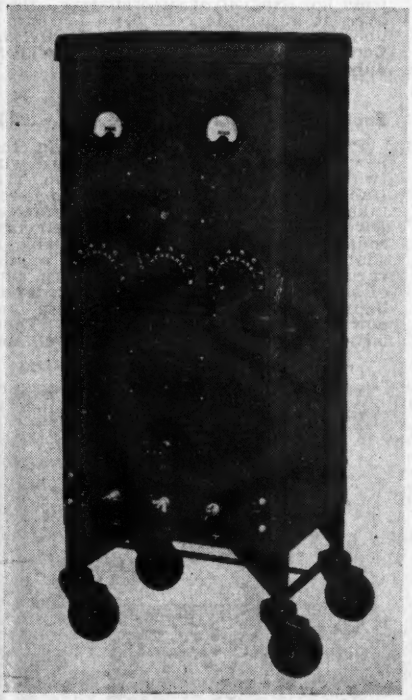
cranking alone; and (4) hand cranking for emergencies. During normal operation with nominal engine cranking torque of 400 lb ft., starter is designed to provide initial cranking speed of 115 rpm. followed by direct-cranking of 60 rpm. Starters are available for one-wire, 24 v. d.c. operation, either clockwise or counterclockwise rotation, with 8 or 12-tooth jaws. Incorporated is built-in meshing solenoid for automatic control of starter jaw engagement and a pre-set friction-disk overload clutch, sealed against entrance of oil. Specifications: Weight, 42½ lb. with 6-in. mounting flange, and 43½ lb. with 7-in. flange; measurements, 6⅝-in. dia. and 12⅝ in. from mounting flange to back head.—**AVIATION, July, '44.**

Dimension Checker..... 102

"Check-Matic" is device for checking dimensions of production parts individually and at high production rate, reports maker, **Interlake Engineering Co.**, Detroit. Provided, it is stated, is automatic inspection of parts up to 1½ in. dia. and 2 in. in height, checking "go" and "no-go" on such dimensions as outside and inside diameters, depth of counterbore, wall thickness, and depth of holes. Parts are placed in holes of machine's revolving dial, which carries them to various gages. Parts failing to meet test are ejected through tubes running from each gage. Standard model has 18-hole dial and is designed to check up to 13 dimensions.—**AVIATION, July, '44.**

Portable D.C. Power..... 103

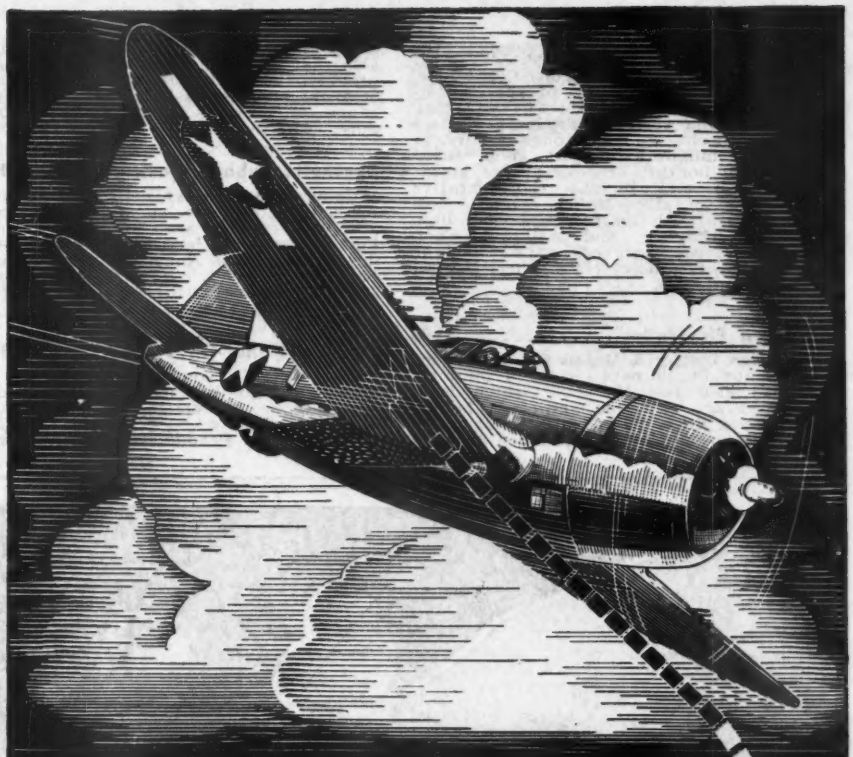
Designed for use on assembly lines, in laboratories, and in maintenance departments by **P. R. Mallory & Co.**, Indianapolis, new portable d.c. power supply provides power for manufacturing, testing, and operating all electrical and electronic equipment in aircraft. Can also be used to taper charge batteries or battery carts. Unit is designed to



operate from 3-phase a.c. lines of 208 and 230 v. Three models are offered: No. VA1500, with d.c. output of 10 to 16 v. at 100 amp. or 20 to 32 v. at 50 amps; No. VA3000, with d.c. output of 10 to 16 v. at 200 amp. or 20 to 32 v. at 100 amp; and No. VA4500, with d.c. output of 10 to 16 v. at 300 amp. or 20 to 32 v. at 150 amp. Models with similar d.c. output, but for operation on 460 v. a.c., are also available.—**AVIATION, July, '44.**

Large Capacity Collet Chuck ... 104

New line of "Master" collet chucks with larger capacity is being marketed by **United Industries**, Detroit. Included are four sizes: ¾, 1, 1¾ in. and 2¾ in. round, and special larger sizes are available.—**AVIATION, July, '44.**



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Simmons hydraulic engineers and production experts have demonstrated time and time again their leadership in the hydraulic field by producing intricate hydraulic equipment for the aviation industry. No other industry demands such painstaking accuracy.

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SIMMONS

Manufacturing Co.

ASHLAND, OHIO

Surface Finish Standards..... 105

University Machine Co., Cambridge, Mass., has developed set of surface finish comparison standards for specifying and checking surface roughness. There are 28 specimens with roughness range from 2 millionths of an inch (rms) to 500 millionths. Blocks are of stainless steel and include representative specimens of all ordinary machine tool operations, such as polishing, grinding, turning, shaping, and milling. Each specimen is engraved with machine operation and microinch reading.—**AVIATION, July, '44.**

Coated Electrodes..... 106

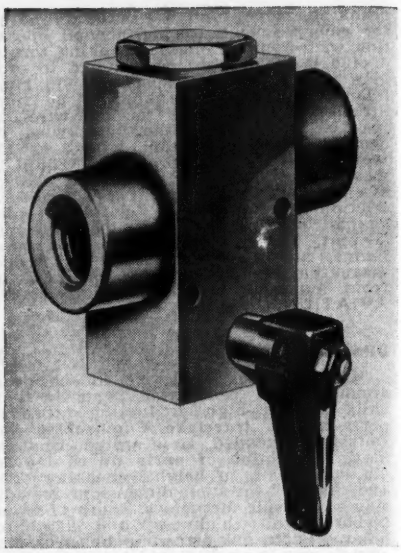
Wilson Welder & Metals Co., New York City, announces new coated aluminum-bronze electrode No. 200, which is a shielded arc electrode and can also be used as a filler rod in carbon arc welding. It is stated it will produce deposits of great strength and hot ductability, also that it can be used in welding most bronzes, malleable and cast iron, and steel, as well as dissimilar metals. Wide range of sizes is offered.—**AVIATION, July, '44.**

Synthetic Rubber Stock..... 107

General purpose synthetic rubber stock for use in oil seals, gaskets, "O" rings, and other types of seals and parts requiring resistance to heat and oil, has been developed by **Los Angeles Standard Rubber**, Los Angeles. New Buna N stock (143-18) is flexible to —35 deg. F., it is stated.—**AVIATION, July, '44.**

Hydraulic Shut-Off Valve..... 108

For aircraft controls, "KwiKloz" is single seated, balanced shut-off valve stated to be unaffected by back pressure either in closed or open position. Maker is **Automatic Products Co.**, Milwaukee.



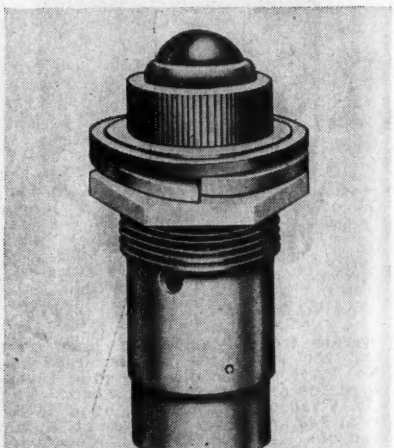
Designed to operate at low temperatures, valve is reported to close instantaneously against maximum pressure of 1,500 lb. psi., and to enable quick change for either clockwise or counterclockwise operation. Outside dimensions of valve illustrated are 2½x2, 2⅞x1¼ in.—**AVIATION, July, '44.**

Glass-Asbestos Textile..... 109

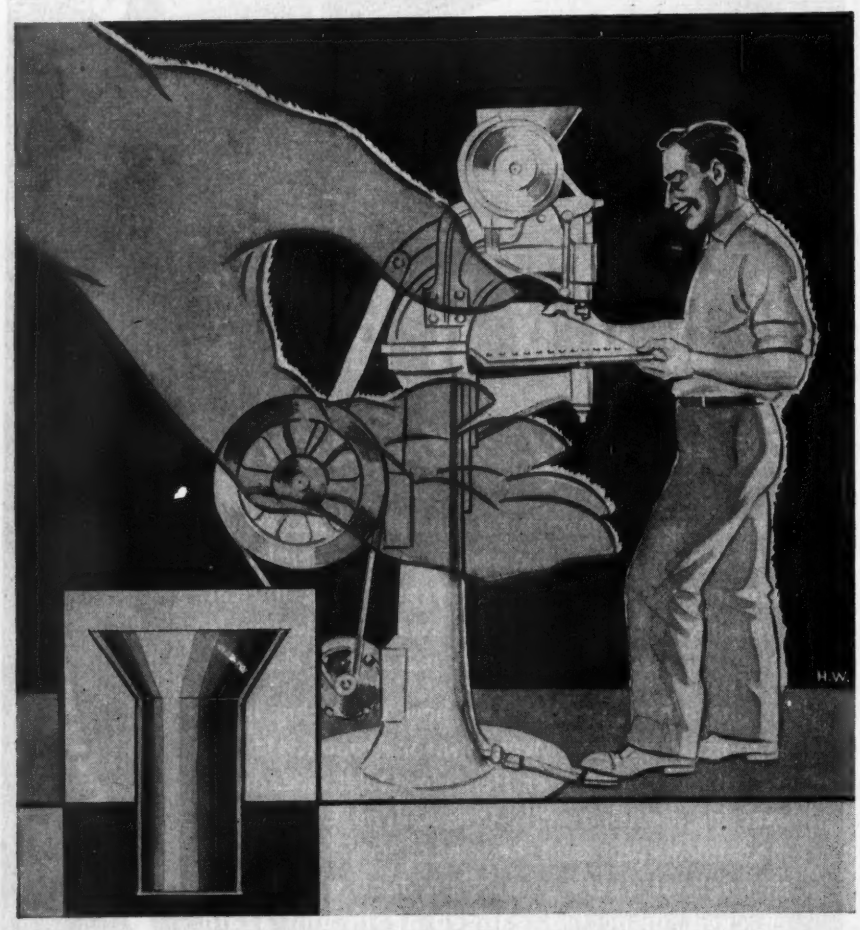
New textile made by combining glass and asbestos fibers is being used in protective boots in aircraft—gun boots, tailwheel boots—also to protect landing gear from hot exhaust of supercharger. Moreover, it is used in cord form for shroud lines of military flares. Made by **Owens-Corning Fiberglas Corp.**—**AVIATION, July, '44.**

Enclosed Pilot Light..... 110

Primarily for ungrounded panels, this new enclosed pilot light is equipped with two solder terminals. Models No. 1110 (faceted jewel) and No. 1111 (plain jewel) take long bulbs; Models No. 1112 (faceted jewel) and No. 1113 (plain jewel) take round bulbs. Unit is also available in shutter type for applications that require variable intensities. Here, a 90-deg. turn of shutter provides gradation from bright light through intermediate glows and down to dim or total blackout. These latter models (1114, faceted jewel, and



1115, plain jewel) provide for round bulbs. Can also be furnished with polarized lens. All models mount in an 11/16-in. hole and have ½-in. jewels. Made by **Gothard Mfg. Co.**, Springfield, Ill.—**AVIATION, July, '44.**



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Russian Women Flyers

(*Continued from page* 117)

us brief the latters background: Born in Moscow in 1912, the daughter of a music teacher, Marina, after finishing secondary school, chose to work in a factory while continuing to study. Since Marina soon became interested in aviation, she gave up her factory job and took a position as secretary to a professor in an aeronautical institute; in this way she felt she would be better able to continue learning about flying. And she did pick up much knowledge of flying instruments in the course of preparing material for the professor's classes.

At 23, Marina was graduated from flying school, where her talents as an avigator, as an organizer of people, and as a commander possessing dynamic energy brought her to the attention of her teachers.

Raskova made many epic flights—from Leningrad to Moscow, from Moscow to Sevastopol, and between other key points—before she became a co-pilot on the Sevastopol-Archangel non-stop trip. Success of this flight later brought Capt. Ossipenko and Senior Lt. Raskova together for their record-making 3,669-mi. non-stop flight from Moscow to a maritime village in Siberia in September 1938.

Marina, then 26, was avigator; while Valentina Grizodubova was again commander, and Paulina Ossipenko was second pilot. The three women brought their plane the *Rodina* (Russian word for "Motherland") to a safe landing after 26 hr. 29 min. in the air. The date was Sept. 24, 1938. The women flyers received national honors; additionally, a special-issue postage stamp was dedicated to them.

As for bombing activities, only recently Maj. Stepan Grigariev, of the Red Air Force, reported that a night-bomber outfit staffed by women under the command of a woman flyer, E. Bershanskaya, had performed such valuable services in bombing enemy railroad junctions, supply trains, and ammunition dumps that grant had been made of the honorary title, "Guards Air Unit." Each of the 36 women received a distinguished service medal.

A women's fighter unit flew with signal brilliance at the battle of Stalingrad; at many other points on the long front women are combatting the enemy. Nor is participation of women in the science and mechanics of aviation something new. From the very beginning, when Russia decided that its citizens should become familiar with aircraft and with parachute jumping, airminded young women as well as young men swelled the membership of the Ossoviakhim, society for defense.

As civilian aviation increased, the number of women pilots grew larger. Mail, passengers, and cargo were soon being transported over the enormous length and breadth of Russia by air, and many of the planes were put under command of women pilots. One of them, Claudia Berezhnaya, made the long run from Moscow to Vladivostock in 53 hr., something of a record.

Planes were needed to transport fresh fish from the north to the cities in the central regions of the USSR. Fruits were brought from distant places without being spoiled. Furs arrived in time for specific sales. Sulphur was flown from the Kara-Kum Desert, and gold was delivered to the big cities in record time. For such transport jobs, women pilots were eligible, since their value in civilian aviation was acknowledged and there were no objections from any section of the population to their playing a major role in this field of Soviet life.

It was the leading women diplomat, Madame Alexandra Kollontay, who paid tribute to civilian women aviators before World War II. Mme. Kollontay (who served successively as Soviet Minister to Mexico, Norway, and now Sweden under the Commissars of Foreign Affairs Chicherin, Litvinov, and Molotov) said she experienced one of her proudest days when, at the signing of a commercial treaty for a new Moscow-Stockholm air route, she found that the director of the Russian civilian line was the very personable young Vera Lomako, graduate of the aeronautical services.

Women introduced parachute jumping as a sport in Russia, and the names of the pioneer jumpers—Kuleshova, Grokhovskaya, Chirkova, and Fyodorova—are often repeated today. Two women, Shishmareva and Pyasetkaya, made women's world record jumps of 26,158 ft. without oxygen masks. Another woman, Kamneva, rang up a delayed-jump mark of 8,856 ft., and young Kouza Malinovskaya, of the Young Communist League, recently won a certificate of honor for a record parachute jump, details of which are awaited.

Such women have inspired others to follow their leads. Before the war, girls used their spare time to learn to fly at the air clubs; and when they showed sufficient skill, they were accepted as pilots. For instance, Katya Mednikova, a worker in the Calibre plant, went on to win records in brilliant speed flights. Katya is now a war flyer, as is also Russiko Zhordana, recently decorated with the Order of the Red Star and made instructor at the Tbilsi Air Club. Among other female military flyers who have distinguished themselves in the war are Podiferova, Lomako, Nesterenko, Uruzovaia, Kazarinovka, and Khomyakova.

Today, 150,000 women engineers, technicians, and mechanics—like Maria Turkova, singled out for her splendid work at Tushino Flying Field—are working throughout Russia. Women are piloting ambulance planes, and they are also flying the planes carrying medical supplies. Women pilots likewise transport blood plasma and fly surgeons from one part of the front to another for emergency operations.

Difficult terrain has not fazed the Russian women pilots. They have not hesitated to fly over snow-capped mountain peaks. On the other hand, in operating seaplanes over the broad Russian waters they perhaps hope to emulate Ekaterina Mednikova, holder of an international women's seaplane record. They can also be found crop dusting in the farmlands and giving aero-chemical battle to the malarial

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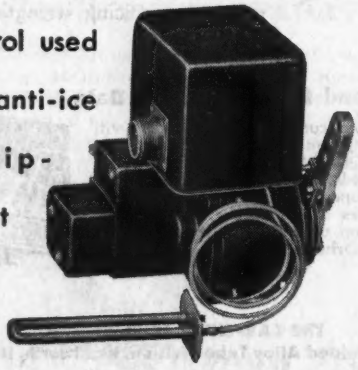
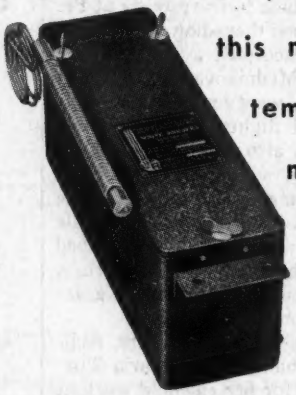


bombing planes. Another product built for our flying forces is



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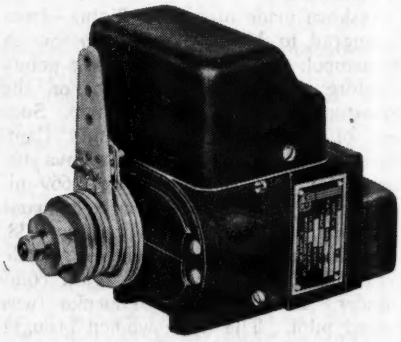

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mosquito. On this aviation front, expert pilots like young Irene Vishnevskaya and pretty Zuleika Seid Mamedova have been in the lead.

Aviation behind the lines, in all civilian pursuits, has long been encouraged for women. In 1939, Marina Raskova aided this movement with a pointed article in *Pravda* in which she asked young women to study to become meteorologists, radio operators, engineers, and technicians—for she foresaw a great need for these services.

But she could not prevent others of her sex from becoming, like herself, full-fledged members of the Red Air Force. A year ago, two young women sky fighters who had seen service at Stalingrad—Lilya Litvak and Katya Budanova—were each given the Order of the Red Star. They had run up a joint score of eleven Nazi planes in one year of service. Junior Lt. Litvak had accounted for three planes in single combat and two in group combat, while Lt. Budanova had downed three German planes in single flights and three more in group fighting.

Lt. Litvak's heroism won foremost praise. In a flight on Mar. 22, 1943, she was assailed by four Messerschmitts, yet managed to down two and elude the others. She had expended all her fuel and ammunition, moreover suffered a bad leg wound; but somehow she got to safety. A few months later, however (August 1943) she was killed at the battle of Kharkov, dying without knowing that the city had been recaptured from the enemy.

Last summer, Marina Ivanova, a 22-yr.-old bomber pilot, received the Order of the Patriotic War for having successfully carried out 125 missions in 70 days. Later, she was badly injured while bombing a Nazi artillery dump.

Another receiving acclaim is the slender 28-yr.-old Vera Mustakova, the mother of two children. A flyer for more than eight years, she is now a war pilot. Her husband, a night pilot, was killed in a raid; accordingly she is determined to fight harder than ever.

Among the men flyers, Russia is naturally proud of war aces like Kostilev, who has 42 enemy planes to his credit. Twice Kostilev was awarded the Order of Lenin and the Order of the Red Banner; also he was recently given the Gold Star and a medal for the defense of Leningrad.

But Russia is also proud of its women flyers, who, in the line of active fighting as well as behind the front and in plane factories are performing 'round the clock. Russia hails their heroism.

Blitzkrieg Goes to Sea

(*Continued from page* 115)

cupies the position of a mobile air base, and as such it must be adequately defended because it provides the point of contact from which aviation can strike at the vitals of the enemy. Development of these points of contact from sea is in direct ratio to the number of carriers employed, but carriers must have proper support, and surface guns must move in after long range air attacks have cleared the way in order to exploit a thrust completely.

Aircraft carriers certainly are the new queens of the seas. Air war is glamorous and tremendously effective. Sometimes we airmen, in our enthusiasm, convey an impression that we believe we can fight a war single-handed. This is not the place to discuss the functions and importance of various branches of surface support, but we must remember that, while air power is certainly the sparkplug of the modern war machine, a sparkplug without the rest of an engine is just as impotent as the engine minus the spark.

The Navy's strength is and traditionally always has been its unity; that split-second teamwork of all arms, each one of which understands the aims and capabilities of the others.

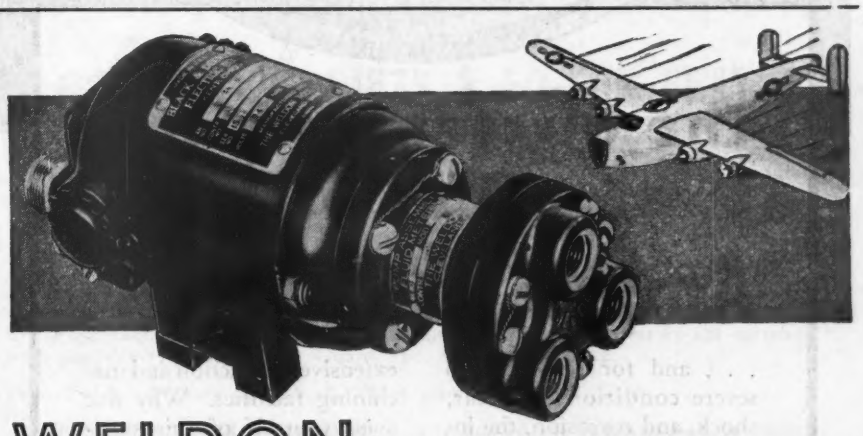
Carrier warfare in the Pacific, although ever more brilliantly successful, is no longer an end in itself. Two years ago it was. Its aim was to stop the enemy, and it stopped him cold. Now, however, the Navy has shifted from a strategic *de*fense to a strategic as well as tactical *of*fense. The carrier and its aircraft have become part of a team, setting the pace and clearing the way for surface operations and amphibious advance. Without carriers, such advance would be most difficult; but without surface and amphibious superiority, victory might be impossible.

The Jap's carrier strength apparently has been cut to ribbons. His carrier pilots are now operating from fixed island airfields, their ranges limited by the immobility of their bases. Although Japan still holds powerfully fortified, strategically located islands, the scores of carriers and hundreds of aircraft which the United States can concentrate at any of those points on any given D-day make us immediate masters of Pacific tactics.

While the fact that those scores of carriers are already in action is a spectacular production achievement, some of the credit for the speed with which this nation recovered from the Pearl Harbor blow must go to foresighted congressmen who authorized new carrier construction before Japan attacked. Progressive Naval leadership which embarked on an escort carrier program six months before the nation was actually at war also must be recognized.

Such foresight was, however, based on facts, not fantasy. Today, varied opinions are being voiced about carriers and aircraft of the future. Some are sheer guesswork and wishful thinking—dreaming, actually—which must not be confused with foresight nor with current needs. Dreams are not the stuff from which victory is fashioned. History records the fate of nations which, whatever their dreams, learned to their sorrow that there is no easy, halfway route to victory. Wars are won with weapons at hand, or in sight.

Aircraft carriers, which have taken the lightning of "lightning war" to sea, provide whatever easy route we can expect. With them we have the weapons of victory in sight.



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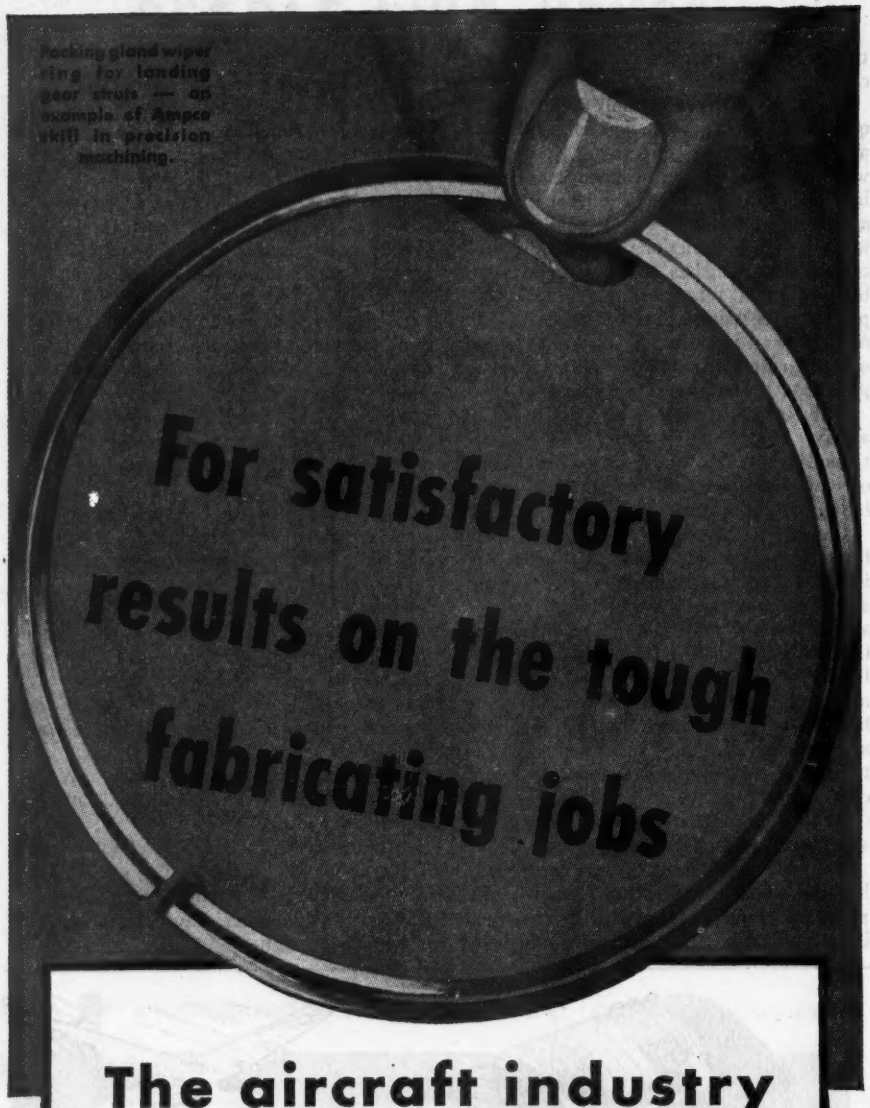
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AA-3

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AMPCO Metal

The Metal without an Equal

Fan Cooling

(*Continued from page* 151)

quired; that is, $\Delta P'' = \Delta P - (P_1 - P_2) - \Delta P' = 0$. In this simplified case, total pressure P_4 before cowl exit (available to accelerate the leaving air to atmospheric pressure outside) is restored to full q_0. Thus the leaving relative velocity V_4 is restored to equal flight velocity V_0, and the forward absolute velocity energy remaining in the air after it has been discharged is reduced to zero.

This is the physical condition representing 100 percent cowl pumping efficiency (also evident from Equation (4), when $V_4/V_0 = 1$, or Equation (5), when $\Delta P''/q = 0$). The power $Q\Delta P$ to overcome the internal cowl and engine resistance is, in this case, all provided by the fan, which deprives the propeller shaft of somewhat more bhp. (depending on fan efficiency), this in turn depriving the propeller of somewhat less thp. (depending on propeller efficiency).

Further assuming, for the moment, that the fan efficiency and propeller efficiency are equal, the propeller thp. is, by these exchanges, deprived of exactly the internal cooling thp. of the cowl and engine.

Again removing the fan, the internal cooling thp. value is restored to the propeller thp., and the cooling air is pumped through the ducting and engine by the cowl, but not at 100 percent efficiency; far from it, at from 80 down to 20 percent efficiency. Thus by removing the fan we may be paying five times as much for our cooling in this highly simplified and special case.

This probably represents the irreducible minimum of cooling drag obtainable by the addition of a fan to a given engine and installation design. Further reduction of ΔP through reduced cowl losses or reduced baffle drop would give further reward in direct ratio to this pressure-drop reduction, but whether this is determined feasible or not, it is seen that under marginal cooling conditions the gain from the fan is very worth while.

In a fan located at the cowl inlet, the pressure drop ΔP, which must be charged against many current cowls, may be greatly reduced, with the large rewards described earlier—because pressure losses as high as $.3q$ to $.4q$ are occurring before the engine in a number of modern installations. Uniform flow conditions achieved with an engine nose fan may or may not cut down these losses; a certain portion perhaps will remain, caused by propeller shank effects.

In any event, in computation of performance with a fan installed, loss actually occurring within the entrance is eliminated entirely from the cowl ΔP requirement, since this region becomes a part of the fan, and the loss is already included and discounted in the figure of static fan boost designed for and delivered at front of engine, not at cowl inlet.

Since a fan helps most when $\Delta P/q$ is high, that is, when cooling conditions are marginal, benefit is greatest in climb, or level flight near ceiling. Fig. 4 represents a typical pair of airplane power-required and power-available curves. The ordinate "B," as is well known, deter-

mines the rate of climb at any indicated airspeed selected, since it is the power left over to raise the weight of the plane after deducting ordinate "A," the power required to fly it level at the airspeed. Application of the fan reduces the power available by a certain small increment; but at a high value of $\Delta P/q$, application of the fan also reduces the power-required curve by several times this increment, resulting in a net gain in power, B', available for climbing, with proportionately increased rate of climb.

Like earnings on common stock after heavy fixed charges, a moderate improvement on a total-power basis gives a large percentage gain for climbing dividends. In many cases, a fan should improve the rate of climb 20 percent—in extreme cases, more.

In 1942 we were all reminded quite emphatically what a fine rate of climb the German Focke-Wulf 190 had (see Fig. 5). Was it coincidence that this ship completely eliminated induced cooling and energized the cooling air by a fan? No indeed. The fan and sliding gill contributed, in all probability, a very substantial percentage of the rate of climb of the FW-190, and they still do.

Ceiling likewise benefits materially from a little boost of thp. Since ceiling also is one of the high $\Delta P/q$ operations, involving marginal cooling and reduced indicated speed, it stands to gain much, with rate of climb, by fan application. The two-engined transport (whose single-engine ceiling leaves a good deal to be desired) or the overloaded bomber offer interesting possibilities for application of this principle in improvement of ceiling.

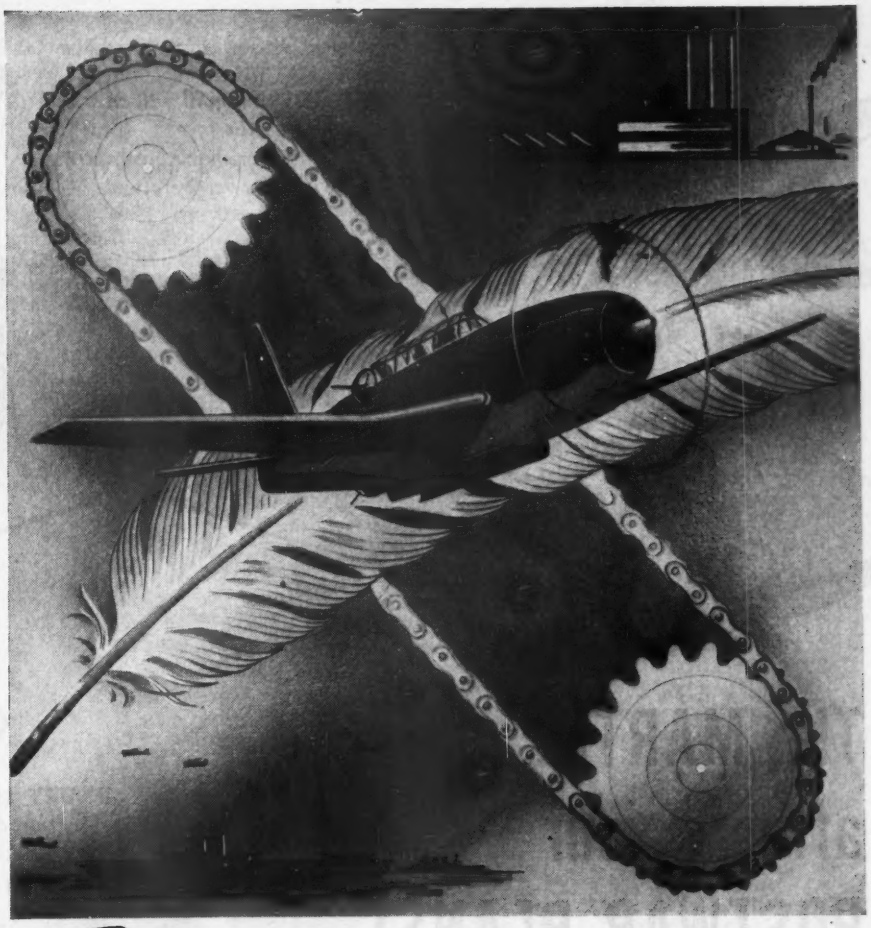
It should be emphasized that it is unnecessary to overcome the entire cowl ΔP with the fan, leaving zero energy wasted in the discharged air. This will usually be found impracticable. When improvement of an existing installation is the goal, the lion's share of the gain from a fan is to be had in raising cowl pump efficiency from values of .20—.40 up to values of .70—.80. Diminishing returns in cooling power reduction are achieved at efficiencies above the latter range. This being the case, reference to Fig. 2 will assist in approximating the power fan boost.

The proper fan boost for a nose installation is that which, after deducting both the no-fan entrance loss $(P_1 - P_2)$ (Fig. 1) and the proposed fan boost $\Delta P'$ from the total ΔP required without a fan, leaves a value of $\Delta P''$ to be provided by the cowling such that $\Delta P''/q$ lies between .5 and .6 (see Fig. 2). This asks relatively little of a fan in order to accomplish much.

Suppose, still as a simplified example, that q in climb is 7 in. of water and the entrance loss (exclusive of any adverse propeller shank effects) is .15 q. Assume further that the no-fan cowl ΔP required is 9 in. Then the fan boost $\Delta P'$ which will bring us to the borderline of diminishing returns in performance gain is only—

$$\Delta P' = 9 - (.15 \times 7) - (.6 \times 7)$$
$$= 9 - 1 - 4$$
$$= 4 \text{ in. fan boost}$$

As stated, the preceding examples have been special cases, in the interest of



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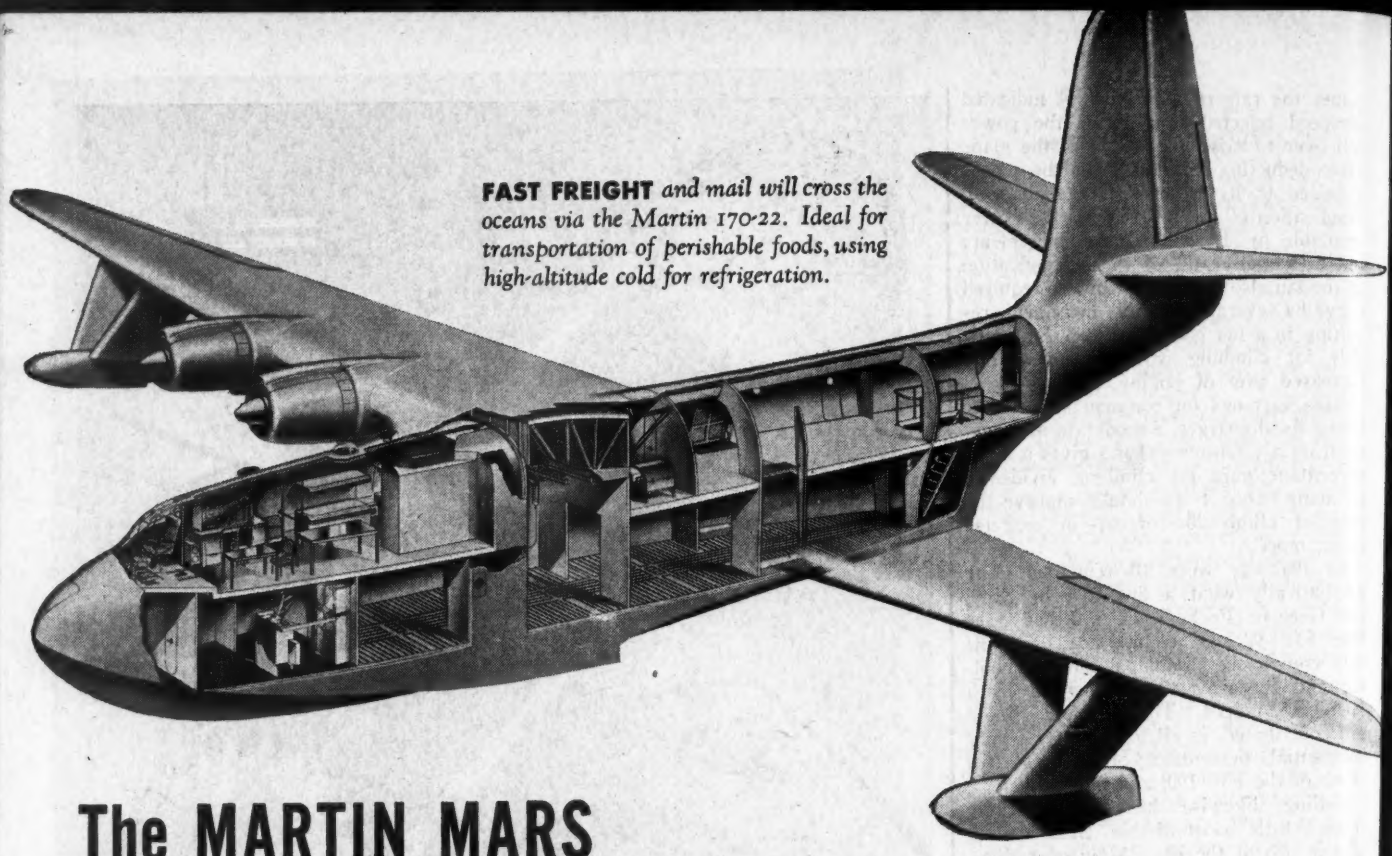

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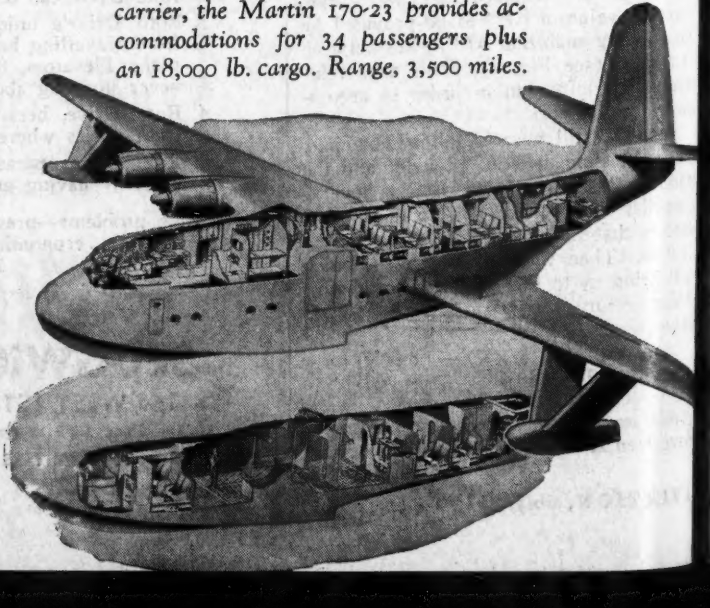

COMBINATION *cargo and passenger carrier, the Martin 170-23 provides accommodations for 34 passengers plus an 18,000 lb. cargo. Range, 3,500 miles.*

simplicity. Fan and propeller efficiencies have been assumed equal. The lower the fan efficiency, the less of an even swap takes place in the sacrifice of propeller thp. for cooling thrust power contributed by the fan. Also, the smaller the portion of the required pressure drop the fan is asked to provide, the greater the contribution the cowl must make in relation to dynamic head q, resulting in lower cowl pump efficiency, per Fig. 2. However, given the assumed values of fan and propeller efficiency, fan boost, drop across the engine and adjacent system passages and volume of airflow, together with an approximation of cowl pump efficiency vs. $\Delta P/q$ per Fig. 2, a logical approximation of performance gain from a fan is mathematically straightforward and easy.

Concluding Part II of Mr. Campbell's article will be presented in August AVIATION.

Going to Pressurize?

(*Continued from page* 156)

amount of body moisture is appreciably increased, hence a greater quantity of air is needed for body comfort. This requirement is frequently handled by recirculation of air. In the normal household, recirculation is accomplished by the use of electric fans. Aboard present-day airliners, the individual ventilator furnished at each passenger's seat does the job. It is probable that if a suitable means of recirculating air is provided, the maximum airflow requirement per passenger will not exceed 10 cu. ft. of air per minute with cabins maintained at temperatures not exceeding 85 deg. F.

These considerations automatically provide the basic air input requirements to any given airplane design. Hence, it is practical to consider that the air source (say, cabin blower) should provide approximately 2/3 lb. of air per passenger per minute. This air mass requirement is based on an air density equivalent to that at 5,000 ft. under standard air conditions, or that which would prevail at 2,000 ft. altitude with an air temperature of 80 deg. F. in the cabin.

In an airplane which normally can carry 40 passengers and a crew of 4 or 5, it would be desirable to furnish a maximum airflow of approximately 30 lb. per minute to the entire cabin. This is based on a maximum airflow of 10 cu. ft. per minute at a density of 0.066 lb. per cu. ft. This, remember, is the *maximum* air flow into the cabin.

In the event that two blowers are to be furnished for the airplane, each would need to furnish only 15 lb. of air per minute and still be capable of furnishing the minimum requirement in the event of failure of one driving engine or supercharger. This is also premised on the probable need of maintaining the cabin at a temperature of not over 80 deg. F.

But what happens when cabin air temperature reaches 90 or 100 deg. F., or possibly higher, as occurs in tropical areas? This condition must be handled in one of two ways: Either provisions will have to be made for at least trebling the maximum airflow mentioned above, to provide greater quantities of ventilating air, or provisions must be made to not exceed the 80 deg. F. mentioned previously.

The combination of high temperature and ventilating flows of 10 cu. ft. per passenger will give the impression of stuffiness in the cabin. Some sort of fan or other recirculating means becomes necessary. It has not been normally realized that increasing air temperature from 70 to 120 deg. decreases the ventilating air mass by 10 percent. This results in an actual, as well as apparent, reduction of available ventilating air mass.

Assume, for example, the cabin level is maintained at sea level pressure to an airplane altitude of 14,000 ft. In this instance, the cabin has been designed to withstand a maximum working pressure of 6 lb./sq. in. Fig. 5 shows the relationship of airplane altitude and cabin altitude, the cabin figuratively bumping along at sea level while the airplane climbs.

The curve indicates that from sea level to 500 ft. the cabin level is "coming up to sea level." While seemingly enigmatic, this is true of *every* airplane of the present day which uses a ramming air intake.

Above 14,000 ft., the cabin rises the proper amount to maintain the cabin-to-atmosphere differential pressure within

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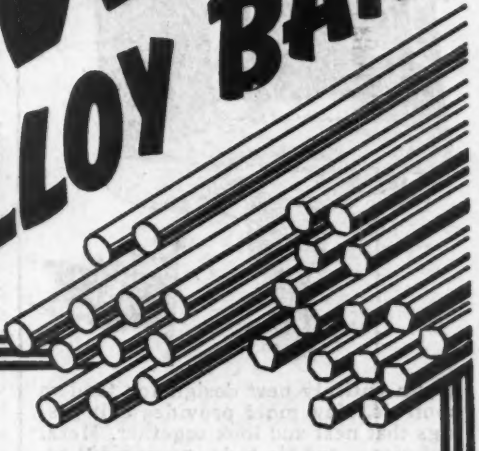

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the safe strength of the cabin structure.

While pressure is thus maintained, the supercharger, blower, or chosen means for furnishing air to the cabin, should be capable of maintaining an essentially constant inflow of air. It is probable that the cabin air inflow should be constant to 14,000 ft., above which it will decrease with air density, somewhat as shown in Fig. 6. While it is possible to maintain the airflow absolutely constant with some complex form of controlled mechanism for the supercharger, it is not considered necessary to maintain inlet airflow absolutely constant. As Fig. 6 shows, the airflow decreases from 30 lb./min. at 14,000 ft. to approximately 25 lb./min. at 25,000 ft.

While it is not expected that a practical airplane will look anything like the craft in Fig. 3 (which appears to be "blowing a lot of fuses" simultaneously), our airplane *will* be subject to leakage which gradually increases as the airplane ascends. Fig. 7 shows an example wherein the slight differential of pressure needed for ventilating purposes at sea level causes a rather surprising amount of leakage. This is based on the assumption that all leaks maintain constant area. Such an assumption may not be correct, since deflections may cause variations in the leakage openings in the airplane structure.

The break in the curve at 14,000 ft. is consistent with previous considerations, wherein the cabin air density decreases gradually above this altitude.

Fig. 6 and 7 are combined in Fig. 8 to show the variation in air outflow which must be controlled by the cabin pressure regulator. Obviously a large quantity of air must be passed through the outflow valve under sea level conditions when only a small pressure differential is allowable to cause this amount of air passage. At altitude, where a large pressure difference is available to accomplish the outflow of air, only a small amount of air must be expelled through the valve. Thus, the outflow valve must have a sufficiently large and properly shaped opening to pass a large amount of air at sea level, but it must also be sufficiently sensitive and stable to control the outflow when the net valve opening is very small at altitude.

Experience on the *Stratoliners* has shown that while the leakage of air from the cabin was between 6 and 7 lb. per minute when the airplane was brand new, this leakage tended to increase with time, due to the effects of engine vibration, landings, and other service conditions. It was also found that the handling of baggage and freight through the cargo hatches damaged door and hatch seals, which also increased leakage. Hence it is to be expected that the over-all leakage may double or treble the initial leakage of any airplane.

At some time in the life of the airplane, the cabin air supply and leakage may become like that shown in Fig. 9. In this case, the regulator valve would reach the fully closed position at approximately 9,000 ft. If the airplane reaches this condition, it is desirable that a major overhaul be scheduled so that joints may be tightened to permit the regulator to maintain the desired control of airplane cabin pressure.

It is possible for the airplane to continue flying for a considerable time, however, because the closure of the cabin outflow valve will indicate that insufficient air is available to maintain the originally specified cabin altitude at the higher airplane altitudes. The airplane cabin will "climb" with the accompanying reduction in cabin air density. Leakage will decrease in relation to cabin air density, to the point where leakage balances inflow. It is not evident that this could ever become a dangerous condition, but it might cause some apprehension on the part of the crew.

While considerable analytic and experimental studies have been made on specific combinations of cabin air supply and cabin leakage, it is not possible to cite the precise results of these studies at this time. It is hoped that within the next year or so it may become possible to present this information, for it will prove to be of considerable interest.

In conclusion it is suggested that engineers keep Fig. 3 in mind when preparing specifications covering the pressurization and the pressure-control of commercial air transports of the future. For this conception should aid in preventing over-optimism, thus smoothing the path to most practical results.

Hole Piercing

(*Continued from page* 163)

each conveyor line is able to handle scores or even hundreds of different assemblies, job organization is well worked out.

A temporary storage space near the start of each line contains parts and tools for each assembly which are placed in bundles, tote boxes, or other containers. Groups ready for work are then transferred to "ready" shelves, from which they are taken and distributed along the conveyor as needed. The accumulation is supervised by a planner who acts as foreman of the line and who has two assistants or leadmen. These workers do most of the detail supervision along the line, help operators who encounter trouble, and see that new set-ups are properly made.

Before any assembly is put into work, however, tools and a set of parts are proved at a bench near the head of the line. There, skilled workers build an assembly, using the jigs, fixtures, and other special equipment provided. If it does not pass inspection the trouble is immediately found and remedied. This proving assures that, when parts and tools are delivered to the line, the assembly will progress as intended.

The foreman-planner selects only those jobs adapted to equipment on his line, and he keeps his line producing even though some items of equipment may be idle temporarily. Company and government inspection are both made at the end of the line. One worker near the end is usually assigned to catch and remedy "squawks."

Part II concluding this series will consider the application of automatic riveting to large assemblies.

Tooling Dock Technique

(*Continued from page* 154)

positioning. In fact, the planes in the tooling dock are set to a tolerance of .002 in. and make it comparable to the jig bore and boring mill in the establishment of machine shop tolerances.

Extreme accuracy of the tooling dock at San Diego can be attributed to the fact that we were able to lay a firm foundation. Despite natural earth tremors and nearby drop hammer operations, the position of the members of this dock have varied less than .001 in. in a period of three months.

The dock method is of particular value in connection with a mass production paneling program, because it cuts time for setting up fixtures by more than 75 percent. This does not mean, however, that the value of the apparatus will decline when the war is over and orders for aircraft becomes smaller.

In point of fact, the tooling dock promises to do away with the old practice of sacrificing production efficiency by cutting tooling costs when producing aircraft in small lots. By utilizing the tooling dock, the manufacturer can avail himself of the advantages of line production by planning his assembly tooling upon the basis of ideal manufacturing methods.

The tooling dock has a pronounced effect upon tool design. It tends to simplify this work because the blueprints and reference dimensions are no longer the medium that controls precision and coordination.

Up to the present time, the principles and methods of this system have been applied only to the assembly of aircraft jigs and master gages. However, the underlying principles will soon be applied in other industries where precise assembly tools and gages are required.

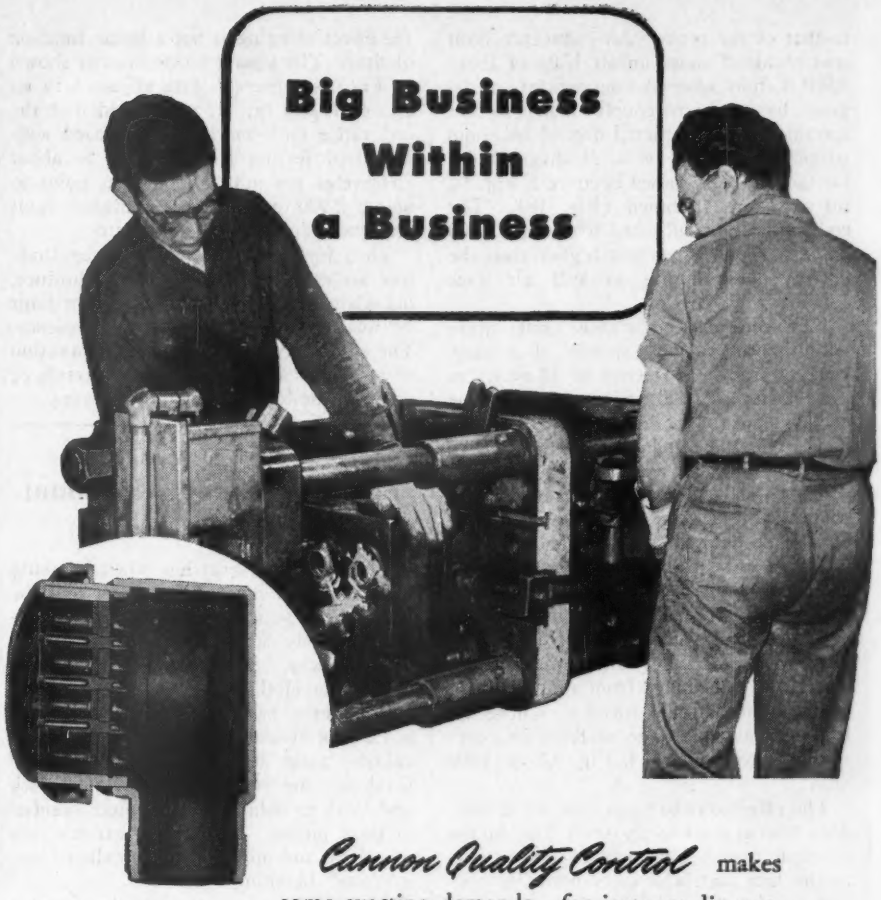
Cellulose Acetate Plastic

(*Continued from page* 165)

centration factor for the notch was 2.1, obtained from the ratio of the endurance limits of the notched and notch-free pieces. The notched specimen was compared with the rectangular machined one because the material in the notched examples, being at the root of the notch, is equivalent to that tested in the machined specimen.

In order to determine the effect of the molded surface on the endurance limit of cellulose acetate plastic about 0.025 in. was removed from both surfaces of rectangular specimens (Fig. 1f). The $\sigma - N$ diagram obtained for those specimens is shown in curve 5, Fig. 12. It was found that the endurance limit adjusted to an age of 11,000 hr. was about 2 percent higher for the machined surface than for the molded surface (see column 5, Table I). Apparently the molded surface has very little effect on the fatigue strength.

Temperature measurements with a thermocouple showed that the temperature of the specimen during a fatigue test was a few degrees above room temperature. It was also shown that a blast of air from a low-pressure high-velocity fan would reduce specimen temperature nearly



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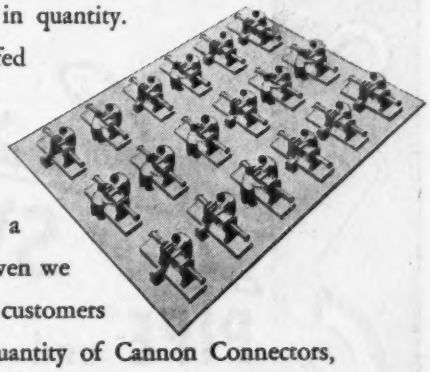

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to that of the room. An endurance limit was obtained under an air blast of about 2,500 ft./min. when the temperature measured by a thermocouple taped to the specimen was less than 1 deg. above room temperature. The $\sigma - N$ diagram for for these tests is shown in curve 3, Fig. 12, for a square specimen (Fig. 1g). The endurance limit, adjusted to age at 11,000 hr. was about 14 percent higher than the corresponding figure in still air (see column 5, Table I).

Five different endurance limits were obtained at various speeds of testing, ranging from a frequency of 42 cycles to a frequency of 2,900 cycles per min. The $\sigma - N$ diagram for these tests are shown in Fig. 13. The endurance limit of curve 8 is not quite as well defined.

Fig. 14 shows the effect of frequency on endurance limit. In this curve endurance limit is plotted against test frequency. The circles represent the actual value of the endurance limit as obtained. The square plotted points represent data corrected for aging on linear variation of endurance limit with time. For this series the age effect was determined from a different set of tests than in the former. Curve 11, Fig. 13, having an age of 8,000 hr., corresponds with curve 4, Fig. 12, at 3,600 hr.

The effect of age from this set of tests does not agree exactly with that in the previous ones. This may be due in part to the fact that laboratory humidity control was interrupted for a short time during the first tests, or it may indicate that the effect of aging is not a linear function of time. The square plotted points shown in Fig. 14 represent data adjusted to an age of 11,000 hr. It was found that the endurance limit markedly decreased with increased testing frequency up to about 750 cycles per min. From that point to about 2,900 cycles the endurance limit remained substantially constant.

Thus for low frequency the magnitude has an appreciable effect on endurance, but above 750 cycles the endurance limit is unaffected by change in frequency. The effect may in part be due to relaxation of stress during each cycle as a result of creep at the low frequencies of testing.

Forming Sheet Aluminum

(*Continued from page* 167)

finish and avoid scratches when blanking bright-finished sheet, the stripper and the faces of the punch and die should be covered entirely with cloth except at the cutting edges. Shellac is commonly used to hold the cloth on the tool.

Combining two or more dies to take advantage of odd shapes for less waste is called "gang blanking." In "stagger" blanking, the sheet is manipulated back and forth to obtain the maximum number of good pieces. Blanking down one side of a strip and up the other is called "progressive" blanking.

The airplane industry has developed a way of blanking aluminum called the Guerin, or rubber pad, method. The metal is placed over small dies which have been carefully laid out so as to use the metal most economically. The bottom of the ram, covered with a heavy rubber pad, comes down, then as the rubber (confined to prevent lateral flow) adjusts itself to the shape of the various dies it blanks out the aluminum pieces. The flexible operation is especially suited to the production of parts in relatively small quantities and saves the construction of costly die-sets.

Blanks can also be cut by several other methods. Guillotine shears, may be used for straight cuts. If provided with a mechanical hold-down, a clearance of one-eighth of the thickness of the sheet is required. A low rake or shearing angle on the upper shear knife will aid in reducing twist in thin stock. When the quantity is too small to justify a special blanking die, circular blanks may be cut by circle shears. The unishear may be used to cut either straight or curved lines, and when sheets are thicker the nibbler can be used to cut to any pattern.

A hand saw or circular saw will prove satisfactory if the blade is kept well lubricated by frequent applications of the grease stick. Light metals can be cut very readily with either type saw, provided it has the right size teeth. High blade speeds (5,000 fpm. for band saws and 10,000 fpm. for circular saws) are desirable for best results. The following figures will give an idea of the performance that can be expected in sawing pure aluminum (2S) on a band saw running at 5,600 fpm.:

Thickness of plate, in	0.47	0.79	1.02	1.18
Feed fpm.	21.8	17.7	13.0	12.4

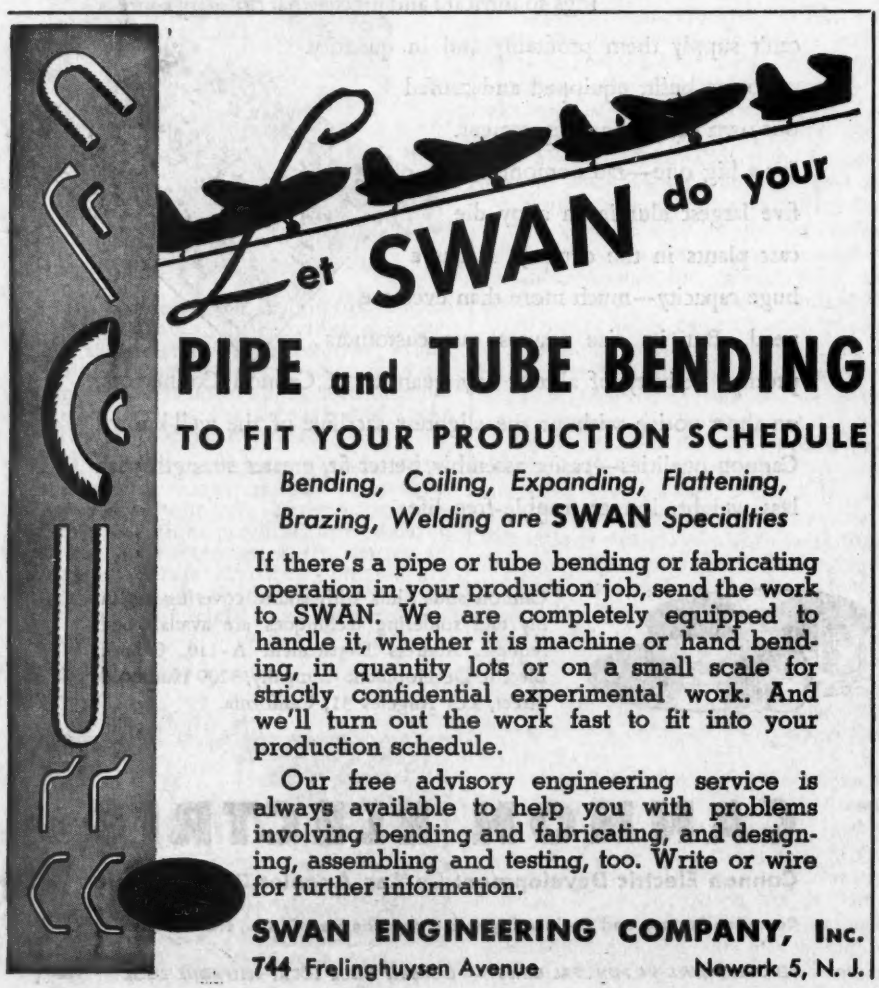
The band saws generally used are of 0.032 to 0.79-in. pitch and of 0.24 to 0.40-in. depth. The teeth should not have sharp internal corners because the sawings would stick at these places. Tooth spacing in band saws usually is about 4 to 5 teeth per inch in the "hardened throughout" type, and either 6 or 8 teeth per inch in the "flexible back" type.

Circular saws with chip-breaker teeth (better than the broad tooth type) have teeth so profiled that one cuts deep and the next one cuts wide. Another preferred type of saw blade has alternate side rake teeth (about 15 deg.) arranged so that one cuts on one side and the next one on the opposite side of the saw cut. Tungsten carbide tipped saws are recommended for cutting aluminum alloys which contain substantial amounts of silicon.

The use of the router machine is a more recent method for cutting stacks of sheet-metal blanks. The cutter is a small diameter, high-speed, vertical milling tool and is guided by a template clamped to the surface of the sheet. Resulting edges are smoother than those of sawed blanks, while the versatility of these machines and the speed with which templates can be provided have made routing the standard method in many aircraft plants for cutting odd-shaped blanks.

Piercing (fundamentally the same as blanking) is the term used when the part cut out is scrapped. If the holes are quite

(*Turn to page* 267)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Tube Turns solved the perplexing dual problem of *volume production* and *absolute quality control* by utilizing their huge upset forge equipment and modern heat treating furnaces — then developing a streamlined production technique which today serves as a pattern for the industry. Proof that light-metal forgings can be produced on a mammoth scale, as evidenced by Tube Turns' success, may well revolutionize postwar thinking in many industries.

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"Close-Quarter Action." With thrilling realism, artist Sessi presents his conception of engagement between an Amer destroyer and a Japanese li cruiser. Destroyer is shown the left foreground.

TUBE TURNS *Forgings for Industry*

small and close together the process is called perforating. Either regular blanking presses or horn presses may be used for piercing and perforating. The tools consist of the usual punch and die. The shape of the hole conforms to the die in blanking, but in piercing it conforms to the punch. The die is ground flat so as not to distort the work, and the punch may be contoured with high and low points.

When a gang punch is used, it is much easier on the press to "step" the individual punches slightly so that they do not all enter the metal at the same time. This practice also gives more accurate alignment of holes. If the punches are small and close together, "stepping" will also prevent "crowding" the metal and pushing some of the delicate punches out of line.

The gage of the metal determines how much metal should be ground off the punches. Each step should be a little less than the thickness of the metal, since too much difference produces a jerky operation. The longer punches should normally be on the outside, surrounding smaller ones. However, big punches should always be longer than small ones, regardless of position. For thus there is prevention of deflection and chipping, which results from crowding.

For piercing, the clearance between the punch and die should not be more than 5 percent of the thickness of the aluminum. If the clearance is incorrect, the slugs will be lifted with the punch on the return stroke. Also, only the punches should be lubricated; light oil applied with a brush is best for this purpose.

Vacuum Pump Efficiency

(*Continued from page* 174)

Capacity Test. Open oil feed line and start motor, allowing pump to run in at speeds given in specifications, until it reaches terminal temperature (given in Table III). Capacity may then be checked at required speeds and setting.

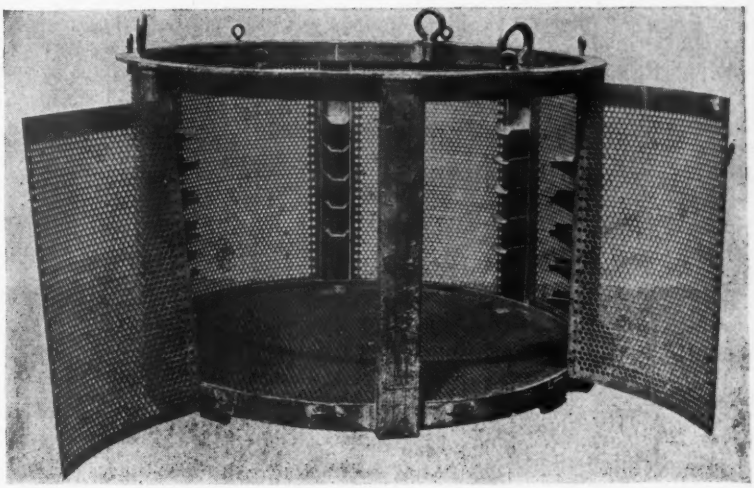
Temperature Rise and Oil Flow. Run pump for 10 min. at speeds and settings specified, recording temperature rise and oil flow (which should be substantially the same as in the table).

Seal Leakage. Immediately following the above, check pump for seal leakage at increased inlet suction and outlet pressure settings indicated in specifications, for at least 3 min.

Should pump fail to provide specified capacity, disassembled and recheck clearances from tables. Substitute new blades, if necessary, to reduce clearances in rotor slots. End clearance for rotor and blades can be reduced by using fewer cover gaskets. Do not remove too many gaskets, for step on cover may bottom on end of sleeve, causing gasket leakage and warping of cover.

If the pump absorbs too much power, recheck assembly to eliminate tight spots, then check lubrication.

In event of excessive air temperature rise, check oil consumption to make sure that pump is properly lubricated. If oil



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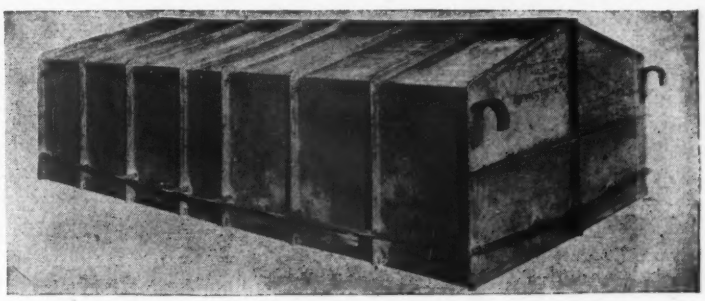

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consumption is too low, probe oil passages with wire to make sure they are not choked or restricted. If oil consumption is not satisfactory, disassemble and check clearances. If it is excessive, check clearance between the metering pin and collar and replace either or both parts. Also make sure the metering pin fits tightly in cover.

Trouble Shooting

If, when installed, pump fails to provide sufficient suction, look for: (a) Leaks in air lines or fittings, (b) kinks or sharp bends in lines or presence of right angle fittings, (c) suction and discharge lines at wrong ports. Check direction of rotation and see that connections are correct.

If pump fails to run smoothly or becomes overheated, difficulty may be: (a) Lack of oil (see that oil passages are not clogged; if lubricated through mounting pad, probe oil passages with wire and make sure gasket does not block oil ducts; if external oil line is used see that it has no sharp kinks or restrictions); (b) Misalignment (coupling and shaft must be properly engaged and mounting flange must fit snugly against engine pad); and (c) Overload (restrictions in either discharge or intake line may make load excessive; no vacuum pump is properly installed if it shows over 7-in. mercury suction close to pump port at normal cruising speed; in no case should suction load measured near pump, exceed 10 in. mercury).

Every installation should be checked carefully to determine exact conditions under which pump is to operate, and where suction loads in excess of 10-in. mercury are found, a relief valve should be installed close to intake port set for a maximum of 10 in. suction. If it is not possible to obtain desired suction at instruments without exceeding 10 in. at pump, lines from pump to instruments should be increased in size and every restriction eliminated.

Overloading causes overheating, excessive oil consumption, loss of capacity, and excessive replacements of parts.

Rebuilding the *Clippers*

(*Continued from page* 177)

scheduled for the job. They are, first: Airplane assembly check, made with the craft mounted on its beaching gear before removal of any component parts, such as hydrostabilizers, tail surfaces, etc.; second, hull check with hull mounted on support jigs before disassembly of the hull structure; third, wing check with wings mounted on jigs before disassembly of outer wing structure; and, fourth, airplane assembly re-check made on beaching gear after all replacement work is completed and component parts re-installed.

Checks are also made for both hull and wings after replacement of each member, and the engineering schedule calls for additional checks to be made at any time desired by the engineering department.

Long before the first of the eight craft scheduled for the replacement program

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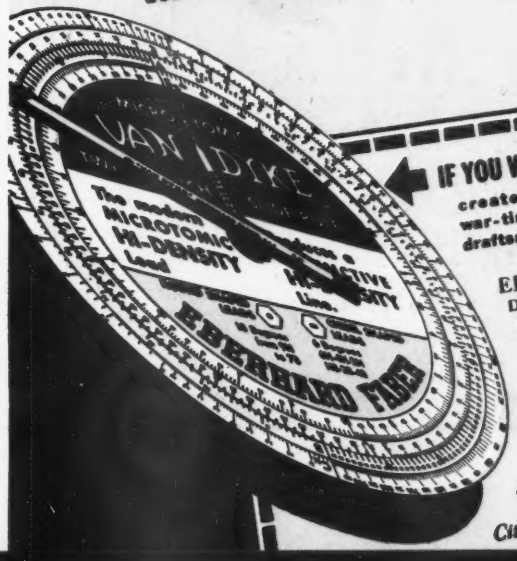

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had been taken from service, the entire operating plan had been organized in minute detail by engineering and shop personal. The section of the report dealing with "Preparation of Airplane," for example, listed and described 34 separate steps in this preliminary procedure.

"Removal of Aircraft Equipment," broken into three divisions, embraced a listing and description of 36 steps. Procedures for disassembling and replacing wing members embraced introductory and general note instructions, together with details on 129 steps for the jobs. Hull work procedure includes a general section and 35 steps. Even re-installation of component parts and equipment are established in detail, this part of the job being broken into 19 separate steps.

This "forehand" work was all done while the *Clippers* remained in service (as one means of getting them back in the air at the earliest possible moment). Despite the fact that a very tight schedule has been set, A. P. Elebash, division engineer; F. J. Zerilli, project engineer; Walter Smith, assistant shop superintendent, and F. Licari, assistant chief of metal shop, firmly believe they will be able to reduce the time on the second plane by 25 to 30 percent, with succeeding craft being "given the works" and put back in service in just about half the time required for the first.

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Franklin Overhaul

(*Continued from page* 179)

piston, otherwise rings may be damaged or broken. Cylinder hold-down stud nuts should be evenly tightened.

Adjustment for valve clearance should be in accordance with instructions on page 165, AVIATION for June, 1944.

Check gaps on sparkplugs and adjust to .020 in. If plugs cannot be screwed into place with the fingers, there are burrs or bruises on the threads. These defects should be removed. On no account should the plug be forced in, for cylinders may be ruined by faulty or cocked threads.

Exhaust stack nuts should not be overtightened but merely drawn up snugly.

If new piston rings are installed, ring grooves should be thoroughly cleaned before rings are placed on piston, the top of which should be cleaned with Crocus cloth and kerosene.

It is not necessary to remove piston from rod to perform the above operation, but if it is desired to do so, all that is required is to push out the piston pin. Crocus cloth will remove scratches on piston, unless they are very deep, in which case a new piston should be used, fitted with a new pin to assure correct clearance between pin and rod.

When new rings are installed, the hard glaze on cylinder walls should be removed with a *spring-loaded* cylinder hone, otherwise several hundred hours may be required to seat the new rings, during which period the blowby will probably ruin both the rings and piston. After reaming, it is advisable to steam-clean the cylinder bore to remove abrasive.

Three different types of Perfect Circle piston rings are used on Franklin engines —3/32 in. Type "200" in top groove; 3/32 in. Type "70" in middle, and 3/16 in. Type "85" in groove directly above piston pin. No ring is to be used in groove at bottom of piston.

Top overhauled engines should be run-in on the following schedule: From 1,000 rpm. to 1,400 rmp., 30 min. at each 100 rpm. increase, total time 2½ hr.; and from 1,500 rpm. to 1,900 rpm., 20 min., at each 100 rpm. increase, total time 1 hr. 40 min. This gives a total run-in time of 4 hr. 10 min.

Aeroprop Replacement

(*Continued from page* 182)

On Models A632S-A1 or -A2, adjust regulator control lever stop plate (Fig. 8) as follows: (a) Facing propeller, loosen stop plate nut and disengage teeth from adapter plate teeth; (b) slide stop clockwise as far as possible; (c) rotate control lever clockwise toward left of airplane to end to travel; (d) slide stop counter-clockwise to contact shoulder of control lever (Fig. 9), and count number of teeth visible on upper side of stop; (e) holding stop plate in place, rotate control lever to center position; (f) slide stop downward three teeth, engage stop plate with teeth of adapter plate lobe, and tighten attaching nut; (g) move control lever through its full travel, checking to see if

cable clevis can move full distance, *making sure there is full control travel on high rpm. side;* (h) install clevis pin and safety with cotter key; and (i) turn propeller to bring oil filler plug into horizontal position, then half fill regulator with oil (Fig. 10), replace plug, and safety with .032 wire.

To lubricate hub (Fig. 11) insert bleeder tool between blade retaining nut and shank, taking care not to damage seals. Force grease into hub until it appears at bleeder, repeating procedure at each hub fitting and socket. Then remove one grease fitting to relieve any pressure built up during the process of greasing. During regular refills, bleeder tool is not required; air may be bled by removing grease fittinsg.

Replace spinner, matching serial numbers. Tap shell into place with hands only, using a special screwdiver to set the countersunk screws. If old model has standard type screws, do not replace with patent head screws.

After installation of a new or overhauled propeller, air must be purged from hydraulic system by setting control in "increase rpm." position and then running engine at about 2,300 rpm. Next, while keeping manifold pressure constant by use of the throttle, move control back to "decrease rpm." setting. Repeat this procedure three times, after which any movement of the propeller controls should bring a corresponding change in engine rpm., indicating that propeller system has been satisfactorily purged of air.

Before flight test, governor action should be tested by running engine up to slightly above normal speed for a few seconds (the plane being secured against moving) when the governor should bring the rpm. back to normal speed. This will indicate that the governor is correctly set to hold the engine rpm. at this figure.

After ground run-up, check oil level and repeat greasing procedure (as outlined for installation).

Industry's Sales Soar

(*Continued from page* 197)

ture showing considerable improvement. In 1942 these companies held only $277,900,000 in cash in their treasuries—$8,000,000 less than their current tax liabilities alone. One year later their cash holdings had grown to $441,884,000 or $105,000,000 above their 1943 tax liabilities.

A year ago there was some reason to hope that Congress would enact legislation aiding the establishment of postwar reconversion reserves. There was much talk about it and many hearings, but nothing has happened and nothing probably will be done about it at this late date. However, the industry is gradually setting up fairly respectable reserves for adjustment, contingencies, inventory losses, etc. On Jan. 1, these reserves totaled $90,911,000 against $62,175,000 the previous year, and today they are well over $100,000,000.

But they will quickly melt away unless the various companies have their financial

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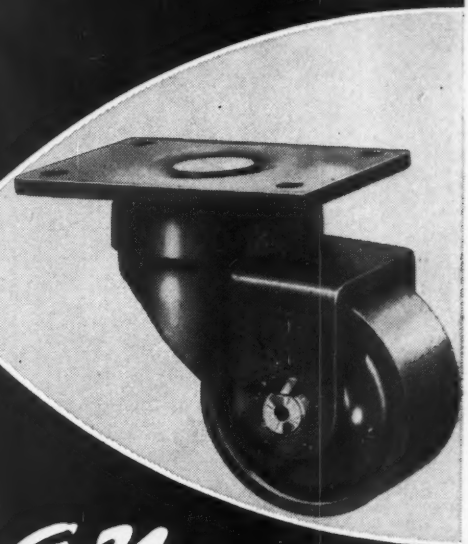

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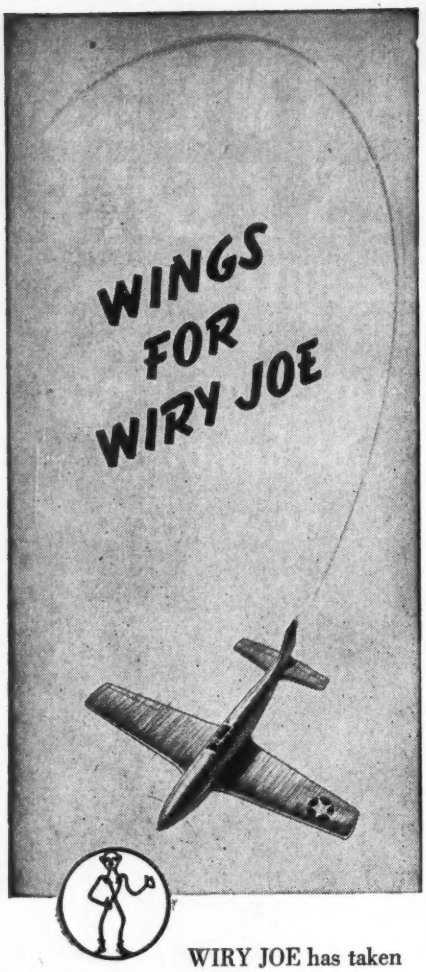

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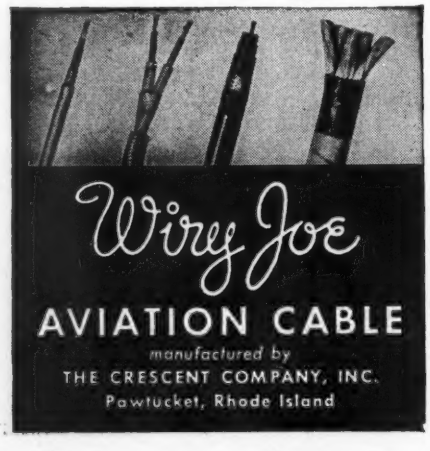


houses in order respecting employee dismissals, excess inventory, and other like matters. These reserves also are small in comparison with the wartime reserves set up by the financially well-heeled automobile, steel, rubber, chemical, and many other war industries.

One striking change in the 1943 balance sheets was the substantial increase in bank debt, wholly apart from government facility contracts. This debt climbed to $192,684,000 against $72,659,000 in 1942. In peacetime such a spurt would surely be called a danger signal for an industry that was singularly free from bank debt before 1940. But in the latter stages of the war it is a decidedly healthy sign. It is the "ounce of prevention" that the industry has taken to ward off any temporary insolvency when cancellation telegrams suddenly come flocking in.

The industry has over $500,000,000 in V and VT credits arranged with the banks and the government. And now that Congress is in the process of legislating a purely-termination type of loan it is expected and hoped that the industry will take advantage of this new credit facility as soon as it becomes available. In fact, the new T loan is designed primarily to supply cash to the aircraft maker and supplier whose quick assets become tied up in terminated contracts.

One of the financial factors that gives greatest concern to aircraft executives is that matter of inventories. Last year the inventory item for the 14 companies surveyed increased to almost an even $430,000,000 against $399,000,000 in 1942. But in view of the huge jump in sales last year the wonder is that the gain was not even larger. The fact is that inventory is being brought under better control every day for most companies.

In the case of Douglas Aircraft, for example, it is understood that company-owned inventories, which stood at $12,800,000 at the beginning of 1944, were under $8,000,000 at a recent date. It is these company-owned inventories, not specifically earmarked against a specific governmental contract, that give the greatest promise of causing future trouble.

The necessity of carrying excess inventories because of raw material shortages largely disappeared in 1943. And with all the current emphasis now being placed on surplus disposal, there is reason to feel that major inventory problems are moving nearer solution, to the obvious benefit of every company's forthcoming 1944 balance sheet.

What is the 1944 composite fiscal outlook for the aircraft stockholder? In the first place he is likely to get a breathing spell from the dire warnings and predictions that aircraft executives felt duty-bound to make during the struggle last year to secure Washington recognition of their problems. And a moratorium on pessimism will help no end to create a better atmosphere for aircraft stocks in Wall Street as well as a better psychological effect upon present stockholders.

Dividends, in the final analysis, are the yardstick with which stockholders measure the success of their capital ventures. Such payments by the 14 companies totaled $23,166,000 in 1943, up from $19,759,000 in 1942. Some small further gain in average payments may be registered this year, although every concern will want to continue the process of plowing back the major part of its earnings into the business. Only by this policy has the industry been able to keep its head above water.

More and more will be heard about cutbacks in war orders this year. Requirements of both the Army and Navy are changing so rapidly that it would be foolish to try to look very far ahead on production figures. But it seems clear now that 1944 will be the peak year for wartime aircraft output.

The cutback in the trainer program is water over the dam. The reduction in Navy fighter production is well under way. Next comes a general cutback in Army procurement schedules for shorter-range fighting planes and possibly light and medium bombers. Changes in the Army program, where emphasis is now on offensive rather than defensive aircraft, will mean no substantial reduction in production until early next year.

The aircraft stockholder's interest has been largely centered in the ability of his company to maintain its financial stability during the last three years of ever-expanding production. The improvement shown in the 1943 reports indicate that the industry is moving more rapidly than the layman appreciates in getting its financial house in order.

Six months more of good wartime housekeeping should see the industry safely over its more serious financial hurdles. It is now becoming a question of gaging the industry's earning power in the first few postwar years. In later articles we will take soundings and submit what clues we find for the aircraft stockholder's consideration.

New Auxiliary Engine

(*Continued from page* 199)

two hardened steel guides of 0.003–0.005-in. clearance. These guides are self-aligning, which simplifies assembly procedure and maintains even pressures in operation.

Since, in a double-acting engine, the crosshead takes all angular thrust, the piston "floats" in the cylinder, main contact between the two being through the rings. Design of the seal between piston and crankcase is such that no bending strain is imparted to the piston rod; thus it is only under normal compression and tension, there being no force other than inertia of the rod, wrist pin, and connecting rod resisting the shift from one set of guides to the other.

Only two crosshead shifts take place in each cylinder during the full cycle: One at the end of the second power stroke, when the crosshead is practically stationary and the connecting rod changes from driving the crankshaft to being driven; the other between compression and the first power stroke. This latter occurs at the moment the horizontal component of the power stroke set up by the angularity of the connecting rod is suffi-

cient to overcome the inertia of the moving parts involved.

Since this is a negligible force at the top of stroke, hammer has been eliminated. This has been borne out by an exhaustive test run especially to check the theory.

For the test, soft steel guides were installed and the engine run continuously till the guides were well worn. No wear was found at the ends of the stroke where crosshead shifts occur, but increasing wear was evident up to the point where maximum pressure was set up by connecting rod angularity.

Difficulty due to failure of the seal around the piston rod between the lower piston head and crankcase is said to have been eliminated in the Tabor-Hedges engine by a simple method. Set in the lower head is a non-ferrous plug, the bore of which is large enough so that the piston rod does not make contact with it. In this bore there are square recessed ring grooves, in each of which are three contracting cast iron rings. The two outside rings have flat outer faces—for contacting the flat sides of the grooves—and inwardly inclined inner faces. This leaves a wedge-shaped space, the apex of which is toward the piston rod, in which the center ring fits.

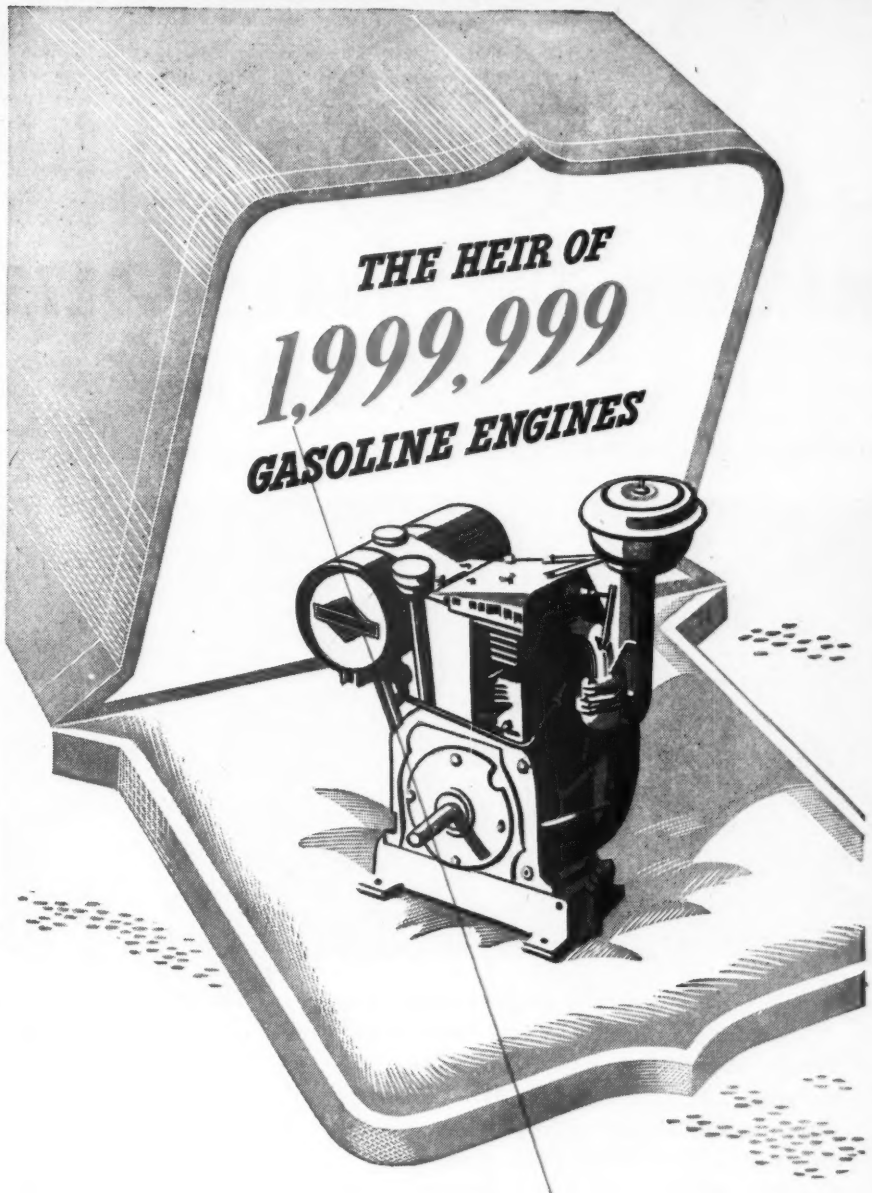
After cutting, the outer rings are lapped to a true fit around the piston rod. The internal diameter of the center ring is large enough so that no contact is made with the piston rod; outer diameters of all rings are small enough to permit the assembly to move freely in a radial direction in the groove. Contraction of the center ring against the slanting sides of the outer rings holds them in contact with the sides of the groove and the piston rod. This results in a labyrinth seal which is reported to have proven so effective that there is no measurable leak through to the second seal. Moreover, this type of seal has proved to be unaffected by heat and has shown no noticeable signs of wear after hundreds of hours of test. Normally two grooves, with sets of rings, are used, but more can be installed if greater compression is desired.

Valves, cams and camshafts, crankshaft, lubrication, ignition, and carburetion follow standard practice.

Since high speed increases cost and shortens the life of mechanical units, the Tabor-Hedges engine has been designed for continuous operation at 2,200 rpm., as compared with units which run at speeds up to more than 4,000 rpm. Test runs have shown the engine will deliver 30 hp. at 2,200 rpm. for continuous operation, under which conditions it is rated at 5.45 lb. per hp. At its maximum horsepower output the engine weighs 5.1 lb. per horsepower.

Designed to use 68–72 octane gasoline, the engine consumes .54 lb. per hp./hour at maximum rated horsepower. However, test runs have been made with 90–100 octane fuel without increasing the 6-to-1 compression rates, and it was found the engine ran cooler than with the lower rated fuel.

Specifications and performance data of the engine are given by the manufacturer as follows:



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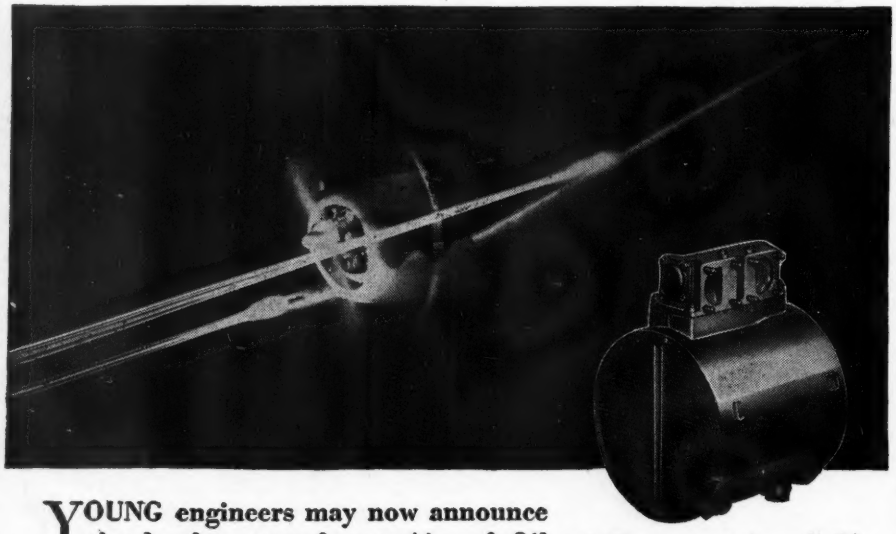

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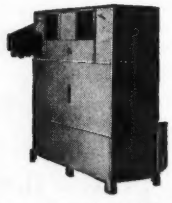

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No. cylinders	2
No. cycles	4
Bore & stroke	$3\frac{5}{8}$ x 3/58 in.
Compression ratio	6 to 1 (for 68–72 octane fuel)
Maximum hp	32 @ 2,200 rpm.
Continuous operation horsepower	30 @ 2,200 rpm.
Wt. (without SD proof box or elec. equip.)	163 lb.
Lb./hp (maximum hp.)	5.1
Lb/hp. (continuous operation)	5.45
Ignition	mag.
Height	26 in.
Width	21 in.
Length	26 in.

Three International Policies

(*Continued from page* 191)

for the use of the hundreds of air bases built under lend-lease and defense programs all over the world—not necessarily assuming sovereignty over the airports, but retaining landing and commercial rights.

In addition, the 17 airlines recognize the right of foreign carriers for reciprocal rights in U. S. territory, with certain commercial opportunities and the right of innocent passage.

The lines are fully aware of the fact that international "horse trading" would require that an equal number of foreign airlines (or at least an equal number of schedules) would be granted authority to operate over all routes. Thus, for example, if seven different American companies each operated one schedule a day from New York to London, then seven British schedules—whether operated by one or more companies—would have to be authorized.

These lines further stated that proper government consideration of the proposals made would create maximum employment for people now engaged in such operations as the Army Air Transport Command and Naval Air Transport Service. In addition, manufacturers could be definitely informed as to the types of aircraft needed, so that preliminary development could take place, with a further opportunity for employing in postwar at least part of the great body of hundreds of thousands of workers now engaged in aircraft production.

The 17 airlines are definitely opposed to a monopoly, whether in the form of a "chosen instrument" or a "U. S.-flag airline," stating that competition has been a traditional policy of this country and is essential to the airlines' continued growth and development. It was pointed out that the majority of developments in commercial air transport in this country had taken place under the competitive system. This position can perhaps be best summarized in the group's following statement:

"The airlines believe and insist that competition is one of the first principles which must be adopted and which should be the base for the establishment and operation of U. S. foreign air routes, if the continued progress of civil aviation, its particular technique, the expansion of U. S. foreign commerce, an adequate system of national defense, and maximum

efficiency in the American aviation industry are to be maintained and developed."

Actually there has been no official stand on the part of Pan American, or its spokesman-president, Juan Trippe. However, during a speech in the last months of 1943, Mr. Trippe pointed out that most countries had concentrated their efforts behind one single company—the so-called "chosen instrument" policy. He told his listeners that the British Government had concentrated all overseas air transport in a single strong company, British Overseas Airways Corp., while formerly there were four British airlines competing with one another and with other foreign airlines as well.

When the other foreign trading nations consolidated their airlines better to meet world competition, the British followed suit and merged their international airlines, pointed out Mr. Trippe, so that now Britain has a single powerful unit, BOAC. Behind this great air transport company, he said, is the full power and prestige of the British Government. The airliners of BOAC, manned by British crews, will fly all the postwar trade routes of the world. In dealing with foreign governments British air transport enjoys the same advantages that British Communications has had since Cables & Wireless was created.

Mr. Trippe declared that the United States can profit by the experience of Britain and other great trading nations. To consolidate the American position, he held that Congress should approve the pending measure which would merge into a single company all U. S. communications facilities abroad, so that they can compete on equal terms with foreign nations. He also stressed the necessity of the early establishment of a national air policy, citing three alternatives, one of which our government will have to choose:

First, shall we have 10 or 15 different airlines, each competing with the other as well as with powerful foreign monopolies? Mr. Trippe pointed out that this system had been tried as long as 20 yr. ago in Europe. Second, shall we have three of four airlines, each restricted to a separate zone? Britain, France, Germany, and Japan tried this scheme for several years, then abandoned it in favor of the single-company system. Or, third, shall we have one strong American international airline, strong enough to compete on even terms with the great foreign-flag air transport monopolies—a community company—owned and controlled, not by any one aviation interest, but by all American transportation interests able to contribute, under an organization plan approved by the government?

Mr. Trippe also declared that although Pan American World Airways System has pioneered this country's international airlines, the government should not consider the position of any one airline or any group of airlines—for the problem is too big for that, the policy must only be determined by what is best for the country as a whole.

While it is rather obvious which policy is advocated by Pan American, it will be recalled that PAA has enjoyed strong political influence with the highest government quarters in Washington. Would this tend to create a single, large Pan American World Airways System, with minor roles being played by other transportation interests?

It has been learned from well informed quarters that this is, in fact, Pan American's hope, that it will be named *the* international representing all U. S. interests, with other American airlines relegated to the position of feeder service.

Of all airlines in this country, United Air Lines has perhaps done more work in actual figures, surveys, and estimates to show the possible trend of postwar commercial aviation. For two years this company has had a full-time staff busy making complete studies of every phase of the past, present, and future air transportation picture. This survey group has been actively assisted by the research and development group of the company's engineering department.

UAL's calculations would indicate that domestic air traffic would increase by 3,000 percent in the 20 yr. after the end of the war, requiring the use of more than 5,000 planes of a 52-passenger type such as the DC-4 (C-54). On the other hand, it is also indicated (even if the figures are contradicted by such authorities as Grover Loening) that but 43 airplanes of 100-passenger type would be able to transport all Class A transatlantic traffic, with a peak of not more than 1,500 passengers per day in both directions.

United, while believing implicitly in the principle of healthy competition where it can be wisely applied, has taken a stand against "free, wide open" competition in international transocean flying. It has proposed that one or more chosen instruments should represent this country, under private enterprise, in coping with the competition of government-owned foreign monopolies in the international flying field. It points out that the plans of the large group of airlines would mean in effect that, if the figures of the surveys are correct, 8 to 17 additional operators would have to share an amount of traffic which could be carried with perhaps as few as 43 airplanes, not even taking any foreign competition into account.

The prospects of postwar air transportation, United points out, are exceedingly bright. States this company: They can best be realized—as the airplane attains its maximum utilization as an instrument of social and economic progress—if we move forward on a sound, business-like basis, independent of public subsidy. The airlines of this country have attained world leadership. Their aim should be to maintain the position of the United States flag under private enterprise on the world's airways and to make the best possible use of this splendid instrument for building a better world in years to come.

United's recommendation, as sole dissenter among all domestic airlines, is as follows: That the domestic and transocean fields be considered separate and distinct, with a realization that one entering the field of the other will contribute nothing that will strengthen our position

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as a nation in the field of international trade. Free American enterprise in air transportation can accomplish what is desirable nationally in that field without resort to wasteful subsidy stimulation.

Certain authoritative persons have pointed out that United's policy would form a "United States Airline," in which all airlines would join as an equal partnership. For example, spheres of influence would be allocated, and (we are merely visualizing) they might be arranged something like this: Eastern and National would fly into the Caribbean and South American countries . . . TWA, United, and AA (the latter via American Export Airlines) would serve Europe, Africa, and India . . . Northwest and Northeast would serve the northern routes —to Iceland and Moscow via great circle routes, and to Alaska together with Western . . . United, and possibly American and TWA, would serve the Orient and Australia . . . and other airlines, such as Braniff and Chicago & Southern, would serve the Central American countries and the West Coast of South America.

Thus the United States would have one over-all airline, with one insignia, but it would be operated by the airlines best situated to fly in the areas as assigned, all very much in the manner in which the Air Transport Command and Naval Air Transport Service today detail the domestic airlines to operate "divisions" of a global air transport system.

Here, then, are the three views of the airlines of these United States, through different approaches, but all having one common goal—an aerial transport supremacy for the American people. Only the *method* is under dispute, not the *goal.*

D-Day Air Power

(*Continued from page* 111)

really learned from the students the true meaning of vertical envelopment, for the Allied invasion of *Festung Europa,* paced by our paratroopers and airborne infantry, far eclipsed anything the Fuehrer had ever even attempted.

Here was the answer to the question repeatedly asked by thousands of Douglas workers, by airline operators, and by passengers: Why so many C-47's, and where are they going? Here was the answer to countless aircraft, piano, and furniture workers: Why so many Waco CG-4 gliders, and where are *they* going? And here was the final word for the "up-and-down" glider proponents—yes, the late Richard duPont, Col. Gable, and their untiring successors, had been right.

But back of the initial operation itself is a story of tireless planning and coordination; planning for months down to the most minute detail, coordination not only with the ground and sea forces but within the Air Forces themselves. For this was the greatest air operation ever undertaken—11,000 aircraft of all types working on split-schedules from widely scattered bases into a concentrated area. It was an epic of teamwork not only by flight and ground crews but by those always-in-the-background boys, the opera-

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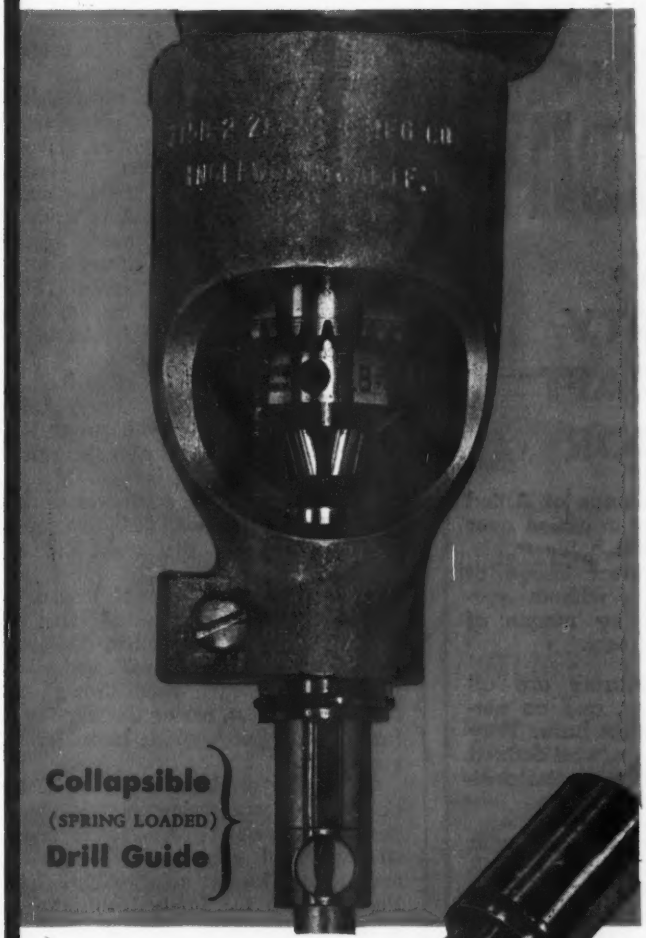

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tions and the traffic control personnel.

Allied airpower had, as a matter of fact, inaugurated the invasion long before the actual amphibious and airborne operations of D-day itself, for the long-range, deep-striking strategic bombing attacks—not mere air raids—of the American 8th, 9th, and 15th Air Forces and their RAF compatriots were as much a part of the job as the naval gunfire covering the landings.

This was clearly evident during the two months preceding D-day, when British-based American and RAF planes topped their schedule of 130,550 tons of bombs by more than 30,000 tons. It became even more clear during the last month before invasion, when the AAF's 8th Air Force operated 27 days out of the 31 for a total of over 30,600 strategic sorties —16,400 plus by the heavy bombers, 14,200 plus by the fighters—and the 9th loosed more than 20,000 tons of bombs in tactical or semi-strategic flights.

Approach to the climax came the night before invasion, when 1,350 heavy American Bombers, together with strong RAF forces, worked their way up the beaches to loose 10,000 tons of bombs. Many of these heavies, because of tireless work of unsung ground crews, flew two, sometimes three sorties that night and next day.

Then, in the first hour of June 6, the 9th Troop Carrier Command came into its own, flying two complete divisions—the 82nd and 101st—in C-47's and gliders to hold the wedge open through five hours of darkness, paving the way for the first assault forces which landed around six o'clock.

Only these pre-invasion strategic, tactical, and troop carrying operations made possible the sea and ground forces' reports on the initial operations of "casualties low" and "losses unbelievably light." Perhaps even the future historians will never be able to assay with complete accuracy just how many Allied lives were saved by airpower. But for comparison, there is the tragic lesson of Dieppe where, without adequate air cover, some 3,000 out of a force of 5,000 men did not come back.

This time Allied airpower was such that Gen. Dwight Eisenhower, Supreme Allied Commander, was able to tell a Canadian unit just before embarkation, "If you see any planes, don't worry—they're ours."

Here, too, was the final answer to prove the American doctrine of a balanced air force: Heavy bombers for strategic missions with, of course, fighter protection all the way; medium bombers for tactical operations, again with fighter protection; and, finally, ground cooperation craft to finish paving the way for air transport.

Versatility of Our Aircraft

But perhaps most important of all was the convincing proof—if such were still needed—of the versatility of American aircraft; a versatility built in from their very conception by the men who designed them, and backed up all the way through production workers to the men who fly and maintain them.

These were no planes designed for one type of operation against a known enemy from known bases; they were the planes designed to operate—as they have and will continue to—from the Far North to the South Pacific.

Here were Douglas C-47's, military versions of a ship designed for peacetime airline use, serving as paratroop carriers, airborne troop carriers, and glider tugs. They didn't even stop at that role; for within four days, with their flying medicos and nurses, they were evacuating casualties, rushing wounded to base hospitals that they might live instead of dying on a beachhead.

Here were Douglas A-20 *Havocs*, performing both their original light bomber tasks, then turning into ground strafers of blistering firepower.

Here were North American B-25 *Mitchells* and Martin B-26 *Marauders*, medium bombers come downstairs to go in under 250-ft. ceilings to bomb and strafe Nazi reinforcements and communications.

Here were some of the Lockheed P-38 *Lightnings*, North American P-51 *Mustangs*, and Republic P-47 *Thunderbolts*—the latter lugging up to two 2,000-lb. bombs—dive bombing and ground strafing. The word "some" is used advisedly, for others of these craft were 'way upstairs in their original fighter role, seeking a challenge from a still-reluctant Luftwaffe and helping to provide "ten tenths" air cover.

Here were some of the Boeing B-17 *Flying Fortresses* and Consolidated Vultee B-24 *Liberators*, called in from strategic operations to help do a tactical job. Again that word "some" is used advisedly, for Allied air power had been built to such a point that others of these types, with their P-38, P-47, and P-51 fighter escort, continued their strategic job of pounding the enemy's sources of supply far back of the beachheads.

And that is a job no less important today than it was before D-day, because the enemy still has resources which must be destroyed before he can be crushed. In fact, the invasion meant not the end of strategic bombing, but called for even more as part of American airpower's prime role—reducing the cost of war in Allied lives.

Boeing *Superfortress*

(*Continued from page* 111)

Through pressurization, efficiency of the combat crew is decidedly enhanced. Pressurization, it is stated, is used in high-altitude approach to, and return from, the target where, while in action, the cabin is de-pressurized and demand oxygen employed. The additional comfort of the supercharged cabin in the approach flight makes the men more alert over their objective.

There are two cabin pressure regulators (by AiResearch), and again since one regulator suffices, there is a 100 percent reserve. Seals are built into the joints of the fuselage. Nose compartments are pressurized and also the 30-in. tunnel catwalk over the bomb bays and the connecting waist compartments. Aft of the latter is an unpressurized compartment. The

pressure, however, is carried through this compartment by two cable conduits to serve the tail-gunner's position.

Use of pressurization brought experiments with double-pane plastic glass having an intervening air space. However, considerable distortion in depth perception through these panes resulted in a return to the single-pane. Later an improved laminated-plastic pane was devised.

Difficulties with the original blister fittings, notably a blister blow-out which sent a man out into empty space (he saved himself with his chute) brought development of the metal grille (seen in one of our photos) for reinforcement. But later a rubber blister-rim was devised which absorbed the stresses, and the grille was abandoned.

On a number of the initial planes, cabin superchargers were used. Development of the present system of pressurization with G.E. turbos followed, it being found that the dual superchargers could supply this added service without drain.

Weight of System Negligible

The circular section of the B-29 fuselage is best for holding pressure, as was determined earlier in the circular-section Boeing *Stratoliner*. Since the pressurization system automatically supplies cabin heat and also reduces the amount of oxygen that needs to be carried, the extra weight of the installation is almost negligible. There is flow control as well as pressure control in the system, and the cabin re-pressurizes very quickly following the de-pressurization phases.

Gross weight of the *Superfortress* is, roughly, twice that of the *Flying Fortress*, and printed reports have said the plane is capable of carrying more than 16,000 lb. of bombs. Striking range of the B-29's may be judged by the fact that after flying the Western China-to-Yawata round trip in their debut bombing of Japan, most of the planes, according to the press, landed back at their bases with encouragingly big supplies of gasoline left in their tanks—enough to fly hundreds of miles (or translatable into a heavier bomb load).

Roominess of the B-29's cockpit contrasts with the tight nose accommodations of earlier bombers. There is considerable space between pilot and co-pilot, and on the panels facing them the former multiplicity of instruments has been minimized, a comprehensive control panel being fitted in the flight engineer's alcove immediately aft of the co-pilot. A step-down position in the nose greenhouse accommodates the bombardier who, by virtue of the sealed cabin's sound-proofing, can converse freely with the pilots. Speaking of this sound-proofing, the *Superfortress* is the quietest bomber we've flown in. With noise and racket obviated and shouting unnecessary, there is decidedly less crew fatigue.

In the compartment next behind the bridge are positions for the radioman (starboard) and the avigator (port). Then the 30-in.-dia passageway extends rearward over the bomb bays to connect with the aft compartments for the remaining crew. Here are found the waist firing positions, followed by a bunk room sleeping four. Finally a long compartment leads to the tail turret.

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True, the ship, a mass of compact installations, is complex throughout. We will provide more of the details a little later on. But our initial interest here is the mastery of manufacture it represents. Few accounts have highlighted the point which was most striking to us—that is, *simplicity* of fabrication.

In choosing a cylindrical-design fuselage, Boeing did much more than achieve speed through clean lines. The company thereby greatly simplified manufacture of the plane—for the 9-ft.-dia. sections of the body and accompanying bulkheads are initially turned out much like huge metal vats and vat covers. Built up-ended in large jigs, the sections are speedily fabricated by a number of employees working simultaneously both outside and inside.

These sections are quickly fitted together into the larger components. In final assembly there are five portions: Nose, bomb bay, bomb-bay-to-tail, three-part tail, and three-part wing. The wing center section, weighing 11 tons minus engines, is carried by overhead crane from the wing portion of the plant and lowered into place in the center section. It is noted that at Wichita, the B-29 wing is made in three parts (center section and two tips) whereas it is understood that at Renton, now in production, the wing is made in five parts in accordance with differing plant accommodations.

The whole scheme of simplified production is evidenced in the strikingly low number of man-hours required to build the ship. The exact figures cannot be given, but it can be revealed that current *Superfortresses* take but $\frac{1}{10}$th the number of man-hours which were required to turn out the first model. In fact, the B-29 today is less expensive in man-hours than was the famed B-17 *Flying Fortress* at the same stage. Wichita is practically at the Army-set rate of production now, and an extra capacity of some 20 percent is still available.

Particularly noted was the exceptionally smooth riveting on this bomber. Virtually all rivets are driven flush, and the aluminum sheets are butt-jointed externally throughout. Likewise, the landing gear doors close exceedingly flush (drag of the *Superfortress* is reported to be double when the landing gear is down —additional evidence of the fine aerodynamic qualities built into the plane).

Greater-Range Airfoil

The B-29's Boeing 117 airfoil section represents further ingenuity. Specially developed for greater-range performance through refinements in drag characteristics, the resultant wing admittedly is given a high loading. But despite this, the desired high ceilings are obtained. The 117 section is strictly a Boeing development, though an NACA section is said to approximate it. The 117 is somewhat similar to the airfoil used on the Boeing *Sea Ranger*.

In internal structure, the wing is of web type rather than tubular-spar type as on the B-17. The web type again is simpler. Multi-cellular, it particularly gives more space for intra-wing fuel tanks. Trailing edge of the wing is approximately straight, except for a portion between inboard nacelles and fuselage. Here, the trailing edge of the huge wing flap hooks downward, decreasing aerodynamic interference between wing and body and minimizing tail buffeting during climb. Dihedral of the wing is 4½ deg., and there is a 7-deg. sweepback. Inboard portion of the wing employs $\frac{3}{16}$-in. Alclad, termed the thickest so far used. Aspect ratio of the wing is 11.5. Maximum wag on the wing tip in flight is 48 in. as compared with 30 in. on the B-17.

The exceptionally large wing flaps constitute nearly 20 percent of the wing area. In takeoff, these flaps are extended 25 deg. In extended position, they increase the wing area 19 percent. Using additional flap in landing, the B-29 "sets down" with comparable speed to the B-17. Incidentally, the *Superfortress* has been landed without flaps. (And it may be noted here that the plane can fly on two engines and has taken off using only three.)

Operation of the flaps is of special interest. Actuated through threaded rods, two on each wing, they roll out and down on five "I" tracks on either wing. Their control is synchronized.

The B-29 is virtually an all-electric plane, using 150 electric motors of 49 different types. Only hydraulic use is in the landing gear braking system. Included in the craft is some 11 mi. of wiring. A Lawrance Aeronautical Corp. 12-hp. auxiliary gasoline engine gives extra power for operation of the gear in takeoff and landings.

Boeing's design of control surfaces and control elements give accent to stability and ease of handling throughout takeoff, flight, and landing. Control forces are termed even lighter than in the B-17 through refinements in design and employment of tab surfaces in the airstream to facilitate control-surface movements. The pilot "feel" is "right on the touch"; in fact, operation of the rudder is stated to require less effort than that of the B-17.

Combination servo tabs and trim tabs reduce the control force on the aerodynamically and statically balanced ailerons to a minimum. Although of different airfoil section and construction, the stabilizers and elevators are identical in plan form to those on the present B-17's. It is interesting to note that the stabilizer airfoil's leading edge turns up, giving in effect an inverted airfoil. This is to obviate stalling of the stabilizer at a critical flight attitude.

The ease with which the ship handles repeatedly impressed us when we flew in the superbomber. We observed that she taxied lightly, belying her great size. She was airborne with little more than a 2,000-ft. run. And in her subsequent climbs, banks, and bursts of speed which demonstrated her fine performance, the smoothness and power seemed incongruous with her weight. We sat cross-legged in the nose, between pilot and co-pilot, as she landed, and we can report that she came in with precision. It was (if poesy will be pardoned) as though she were guided in an invisible groove curving gently to merge with the runway.

With such a mammoth craft, we had expected something of a jar at impact, but none materialized. It is stated that the B-29 can land and take off in shorter space than the B-17.

To continue with the description of the plane, design of the B-29's nacelles called for incorporation of a single large air duct in the nacelle nose, thus giving a frontal oval shape. Further, sufficient space is provided in these units to accommodate the retracting landing gear and the dual superchargers while still retaining reasonable accessibility to the nacelles. The practical final design was an adjudication between the project engineers (who strove for a unit housing all needed equipment) and the aerodynamic engineers (whose purpose was minimum size and maximum streamlining for speed).

In development of the bomb bays, versatility as well as size was achieved. The initially planned bays accommodated a great weight of bombs, but only in the larger sizes. Through lengthening of the bays (and accordingly the ship itself) there is now accommodation for as great a weight in small "eggs" as in large ones.

First Dual Nose-Wheel

Use of a dual nose wheel in the B-29 landing gear—first such double unit ever devised—was necessitated by the extreme weight of the *Superfortress*. There were, accordingly, the problems posed by weight of the unit, also its steering and retracting. Wheels of 3-ft. dia. were finally decided upon, while those of the main undercarriage measure 56 in. The latter are Goodyear 16-ply Nylon S. C. synthetic tread tires. It is noted that the B-29's C.G. lies 15 ft. forward of the main landing gear. Weight of the landing gear totals slightly more than 7,000 lb.—roughly 6,000 lb. for the main undercarriage and 1,000 lb. for the nose-wheel gear.

Turning to the engines, the reduction gear employed affords an extremely low ratio, revolving the propellers only 35/100ths times as fast as the rpm. of the engines. For aerodynamic reasons, it was essential to keep the speed of the prop tips sub-sonic, yet utilize maximum engine power. Thus, the airscrews turn unusually slow; but speed of the tips, at the periphery of the 16 ft. 6 in. dia., compares with the speed of tips on other planes.

Construction of Boeing's *Superfortress* was actually underway—in certain components—before its entire design was completed. Thus, in numerous instances portions of the airplane virtually were blueprinted after, rather than before, their construction. The B-29 is stated to have had no major "bugs"—except the "lack-of-time bug." Yet even this one was ironed out. With painstaking stick-to-it-iveness, the men behind the B-29 kept pushing the job to completion. They concentrated their efforts on whatever phases of the program could be attacked "fustest" with the "mostest" of designs, materials, and workers. The sequence didn't matter; getting the job done did.

Preliminary tunnel tests, made at the

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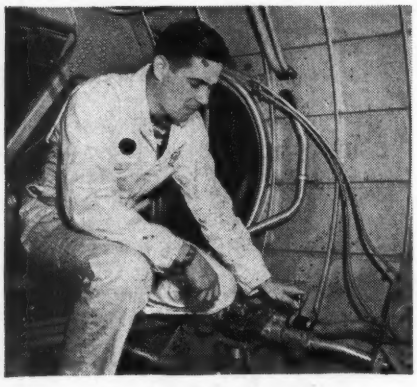

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University of Washington and California Institute of Technology, won the Army order for three "X" models. But flight testing a plane which you haven't yet built is impossible. Not *entirely* impossible, though. Fact is that Boeing did flight test many portions of the B-29 control systems, including all tail surfaces, before a single *Superfortress* was flown.

Various B-29 control surfaces, scaled down to B-17 size, were tested on a B-17C *Flying Fortress*. Thus the ailerons were checked. Next, scale-model tail surfaces were put through their paces on a B-17E. And tests on a scaled-down B-29 nose-wheel gear were made on a Douglas A-20 at Wright Field.

Hydraulic-Jack Static Tests

In later tests of the wings, 300,000 lb. of pressure was required to prove the structures, and the former lead-shot-sacks method of static testing was impractical. Answer was a specially designed system of hydraulic jacks, which brought a great saving of labor and more accurate application of loads. Finally, according to Army stipulation, the complete airplane frame, with weight inside to simulate full equipment, bombs, fuel, crew, and ammunition load, was free-dropped from a point 27 in. above the floor. The *Superfortress* successfully passed two such tests, one in horizontal position and one in inclined position.

Vibration in the plane has been reduced to a minimum. At first, magnesium was employed in the fabrication of the tunnelway over the bomb bays, but because this structure tended to vibrate, there was a switch to dural.

Manufacture of the *Superfortress* involves basically the same principle as that used in building the B-17's—that is, precompletion of major sections on separate lines before final assembly. Because of the economy of production effort achieved in the B-29, it has been possible to employ hastily recruited, speedily trained personnel. Boeing at Seattle had started the tooling project while the bomber was still in the preliminary design stages.

A major consideration was the joining of the various sections of the plane, and therefore many man-hours were initially expended to obtain a production joint to fit together various sections of the plane with bolts, using a torsion wrench, and with no splicing of beams or skin laps required.

Master gages were designed and manufactured to maintain interchangeability of all major *Superfortress* parts no matter where built. Moreover design for production is further evidenced by the clips which tie the circumferentials to the stringers, inside the fuselage skin. B-29 stringers, unlike those of the B-17, do not pass through slots cut in the circumferentials. Instead, the stringers are riveted to the skin and the circumferentials are attached to the stringers by clips.

Number of clip designs required in the plane was finally narrowed down to six, three left-hand and three right-hand. Rivet holes on the clips are pre-punched, full size, as are the matching holes in the circumferentials and stringers. The clip is riveted to the circumferential as a

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subassembly operation. The stringer is positioned in the jig by pre-located coordinated holes, and the circumferential and clip is attached to the stringer by one Cleco pin.

In the other hole a rivet is driven. Then the Cleco pin is removed and the second rivet is driven. In effect, this is pre-matching holes on a large aircraft structure so that parts will fit together handily, yet very close tolerances are achieved.

In outline, there are five airframe plants in the B-29 program—Boeing at Seattle, Renton, and Wichita; Glenn L. Martin at Omaha, Neb.; and Bell Aircraft at Marietta, Ga. A major subassembly operation is handled by the Fisher Body Div. of General Motors at Cleveland. Instituted was a B-29 Committee, similar in pattern to the successful Boeing-Douglas-Vega Committee coordinating production of B-17's.

Working through various subcommittees, the B-29 Committee coordinates procurement of materials and the key phases of the work through the hundreds of subcontractors and numerous subassembly operations. Further, it prepares and maintains master production schedules, coordinates tooling requirements and distributes all design-change instructions among prime contractors. The Committee's offices are located in Seattle, where sessions are held regularly. It may be noted that there have been no subcontracting delays.

Firms Contributing

All the companies contributing to the program cannot be cited in this short space, but a few specific mentions may be made for perspective: The 2,200 hp. engines are now coming from the huge Dodge-Chicago plant of the Chrysler Corp., though Wright is biggest producer; General Electric developed the fire control system which actuates the *Superfortress* guns; Bendix Aviation Corp. supplies a super-generator; De Soto Div. of Chrysler makes noses, wing edges, and engine cowling covers; Minneapolis-Honeywell produces the automatic pilot; Libbey-Owens-Ford contributes the bullet-proof glass employed; and United States Rubber Co. delivers to the ship more than 200 rubber parts weighing nearly 5,000 lb. Others which may be named are A. O. Smith Corp. (landing gear); Jack & Heintz (landing gear motors); Goodyear Aircraft (fuselage center sections and empennages); Chandler-Evans Corp. (carburetors): also Briggs Mfg. Co., Cessna Aircraft, Firestone Tire & Rubber Co., Hudson Motor Car Co., Maytag Co., Murray Corp. of America, Ohmer Register Co., Ryan Aeronautical, and Shakespeare Products Co.

Boeing of Wichita makes some 40,000 of the total of approximately 55,000 parts (not including rivets, etc.) employed in the superbomber.

Additional notes: It is stated that to the best of ability design of the B-29 *Superfortress* aimed at ease of maintenance of the ship and interchangeability. Means to supply the B-29's operating in the 20th Air Force have, wherever possible, followed the channels already set-up (see news section for story about the 20th Air Force). Because of the huge

size of the bomber, it was necessary to devise large handling facilities for outside maintenance and repair.

The company reveals that a transport-version ship, as yet undesignated, will be coming. It is stated that the new 117 airfoil and pressurized-cabin development are well fitted for such a craft. However, the specific bomber design is not considered suited for transport work.

Of leading interest in our Wichita visit was the detailed demonstration of the construction of the wing. A total of 34 extrusions are incorporated in the wing, 17 on each side. A heavy extruded duralumin chord is used for the web spar, Weighing 255 lb. when machined, this chord is termed the largest employed in a production airplane.

Wing Spar Chord Practice

The following traces the right-hand front wing spar chord from the time it is received at the Boeing-Wichita warehouse until it reaches its ultimate position in the *Superfortress:*

Raw material is received in West Warehouse No. 1, at Crib No. 47.

To Shop 120. Farnham Mills. 1. Straighten (spar chord, 25½ ft. long, supposedly is straight when received, but process here is to make sure); 2. Mill face (process of milling down face of chord to specifications. Skin is later fastened to milled face); 3. Mill leg; 4. Mill taper on inside face; 5. Mill inside face of flange; 6. Mill warp on outside face; 7. Saw to length (this calls for chord to be cut to exact length of 202 in.); 8. Straighten (milling and sawing reduced spar chord to approximately 217 lbs.; second straightening process is to make certain no bends have resulted). **Band Saw:** 9. Rough cut scarf (process of cutting out scarf, or section, where right-hand spar chord will eventually be joined with left-hand chord in center of airplane); 10. Mill scarf; 11. Mill side scarf, outboard (for later joining with outboard portion of inboard spar).

To Shop 122. 12. Router operation (sections of chord are routed out for later fitting-in of other sections of wing); 13. Drilling operation (this is drilling of holes which later will be used for fastening on panels, or skin); 14. Inspect.

To Shop 420. 15. Anodine (chord is immersed in a liquid bath to give it a protective finish); 16. Inspect.

To Production Stock No. 11. Completed as an individual piece, chord is placed in production stock until needed. After being taken out of production stock, next route is as follows:

To Shop 260. Assemble into spar assembly, Station 202-202 (where lower and upper chords are joined to make a spar assembly); 1. Drill chords and webs, make joint at Station 0 (lower and upper chords are joined by means of a web, then right-hand and left-hand assemblies are placed together by means of a scarf joint at Station 0, which is center of airplane); 2. Rivet assembly; 3. Inspect.

To Shop 410. 4. Paint; 5. Inspect.

To Production Stock No. 11.

To Shop 260. Assemble into spar assembly, Station 510-510. 1. Make scarf joint at Station 202 (two outboard portions of inboard spars are scarf joined to inboard portion at this point. Station 510 to 510 means it is 510 in. from extreme ends to Station 0, which is center of plane); 2. Complete inboard front spar assembly.

To Shop 265. Wing jib. Assemble spars and ribs, rivet panels (skin), and join trailing edge. (Front and rear spar assemblies are joined at this point by means of ribs; fuel tanks are later fitted between ribs).

To Shop 270. Wing floor (complete structure of inboard wing).

To Shop 271. Wing primary assembly (installations on inboard wing, including fuel cells, landing gear, nacelle fairings, tubing, cables, etc.).

To Shop 361. Joining position No. 1 (join inboard wing to fuselage, and complete nacelle installation and install engines).

Review of Patents

(*Continued from page 210*)

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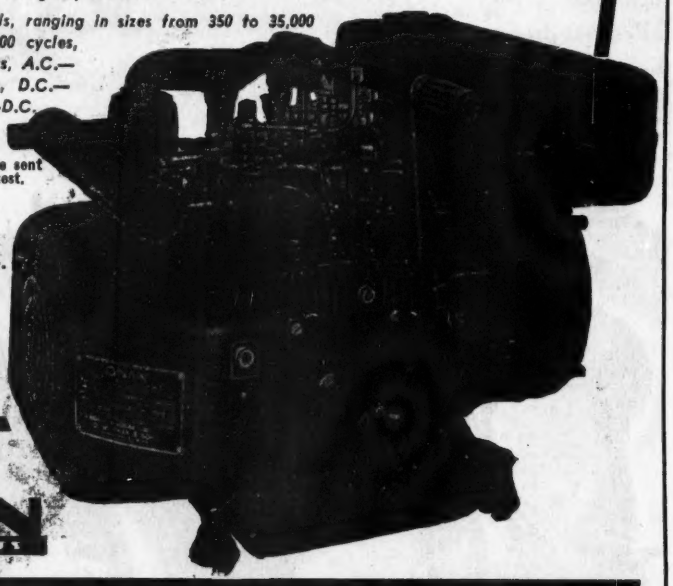

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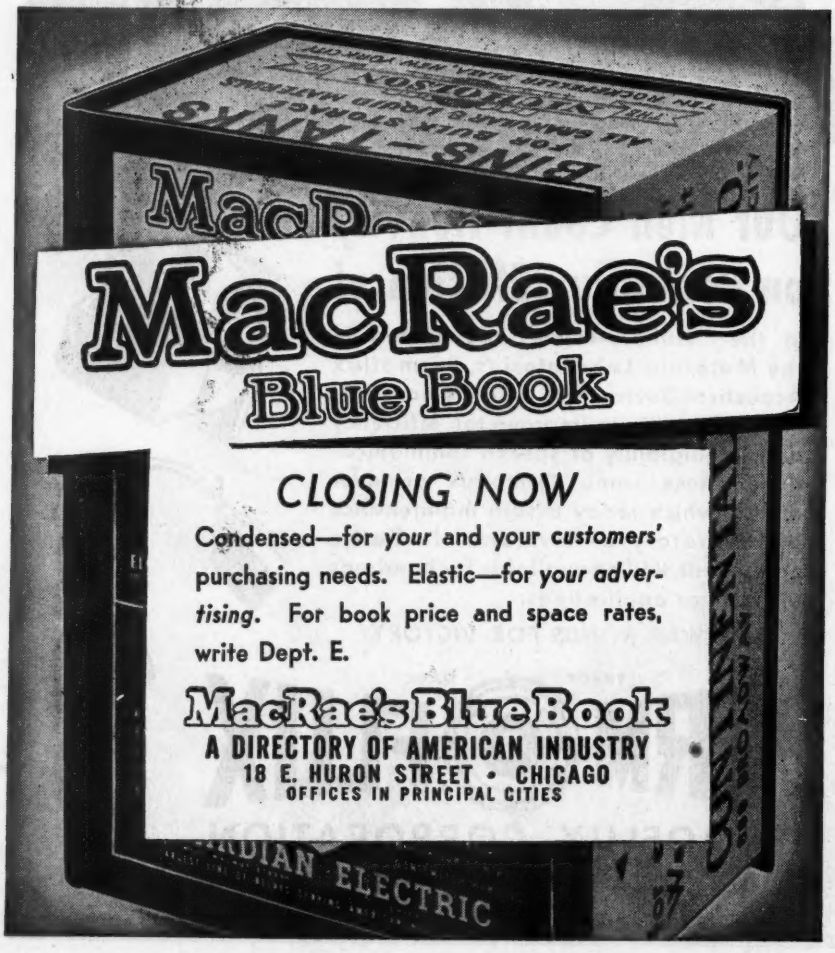
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ment. Angle of attack of flap can be varied as desired. Guiding tracks incorporated can be variously curved to control positions.—2,348,105, filed June 2, 1941, patened May 2, 1944, E. O. Richter, assignor to Lockhead Aircraft Corp.

Mounting for Helicopter Rotor comprises stationary hollow upright column fitted in body of craft and embraced by rotatable sleeve. Mounted on sleeve is head from which rotor blades project. Blades, adjustable for varying pitch are mounted in a horizontal bearing in head. Flange and groove fitting is employed, and bearing is split so blade may be readily mounted or dismounted. A second bearing gives further rigidity and support.—2,348,249, filed Feb. 8, 1941, patented May 9, 1944, C. Ferro.

Airfoil Designs. Construction here aims to provide increased values of lift over wide optional range of lift-to-drag ratios for relatively slow speed flight, as in takeoff, climbing, and landing, and is also designed to reduce drag in normal high speed range, to provide substantially improved lift-to-drag efficiency for greater economy with increased loads and speeds. Included are stagnation slot, permeation passage, movable leading edge slat section, intermediate relatively fixed main airfoil portion, and one or more rearwardly disposed movable sections or flaps terminating at the trailing edge, the several components combining to form a basic airfoil profile.—2,348,252, filed Nov. 23, 1940, patented May 9, 1944, and 2,348,-253, filed Aug. 1, 1941, patented May 9, 1944, R. W. Griswold, II.

Airplane Pickup Mechanism calls for catapult which projects article upon pickup of flexible loop connected to article on catapult. Provided is simple form of mechanically operated catapult latch release.—2,348,342, filed June 22, 1942, patented May 9, 1944, E. G. Hill, assignor to G. T. Smith and E. G. Hill as trustees.

Undercarriage Invention. Offered here is frictional damping device acting on cylinder member of landing strut, device being controlled by load on strut to afford variable damping increasing with dynamic loading of strut. Degree of damping is reduced substantially to zero when strut is unloaded (i. e., when airplane is airborne) to give free operation of self-centering mechanism acting on strut. A frictional brake acting on cylinder member of strut is operated by pressure derived from, and proportional to, loading of strut.—2,348,493, filed Dec. 30, 1941, patented May 9, 1944, S. MacD. Parker, assignor to Automotive Products Co., Ltd.

Book Reviews

(*Continued from page* 210)

MATERIALS AND PROCESSES, edited by J. F. Young. John Wiley & Sons, N. Y. 628 pages, graphs, photographs, tables, index. $5.

A broad study of the materials and manufacturing processes employed by engineering designers for all crafts. Main objective is resolving of the problems of selecting proper materials for any given or projected apparatus. Divided into the two categories of its title, the book treats copiously of the nature of materials and the processes by which they are worked and finished. Covered are late developments in new materials as well as standard metals, including consideration of plastics and their uses.

AEROSPHERE, 1943. Aerosphere, Inc., N. Y. Edited by Glenn D. Angle. $15.

Packed with factual data, this big 1943 issue of "Aerosphere" offers readers an over-all compendium of flying equipment just as the Allied invasion of Europe brings the air war over the continent to a grand climax.

The historical introduction to the subject is pointed and profusely illustrated, and preceded it are a number of short articles by several military and naval experts, including Gen. Arnold, who lauds this "full record of our airplanes which have gained superiority over the enemy on our eight fighting fronts."

Body of the book is divided into four main parts, devoted to Modern Aircraft, Modern Aircraft Engines, Aircraft Statistics, and a Buyer's Guide.

The first section devotes 300 pages to a well-illustrated gallery of the aircraft

of all countries, with each plane photograph accompanied by specifications on points of its construction and performance. A subsection includes a listing of the chief aviation sequences of each country.

Modern Aircraft Engines, second of these sections, follows the illustrative plan and includes many diagrams of plane power plants. It concludes with a table of principal specifications. Aircraft Statistics supplies information on aviation records and competitions, also includes a listing of inspectors for the CAA, foreign diplomatic aeronautical representatives in the U. S. A., statistics on many government bureaus connected with aviation, and numerous miscellaneous data tables. The Buyer's Guide, comprising listings of aviation firms and products in foreign countries, concludes the volume.

20th CENTURY ENGINEERING, by C. H. S. Tupholme. Philosophical Library, N. Y. 201 pages, illustrations, index.

Primarily records engineering triumphs of the past few years. Aviation is covered in a highly compact chapter.

AIRPLANE ENGINE MECHANICS QUESTIONS AND ANSWERS, by Rolla Hubbard and Augustin Dilworth. McGraw-Hill Book Co., N. Y. 260 pages, index. $3.

These questions and answers have been prepared for all types of aircraft workers and "assume that the reader is familiar with the fundamental principles of internal-combustion engines and their various accessories." They have been designed "principally to aid in the preparation for obtaining a CAA airplane-engine license." The elements of engines are covered, and there is a special section devoted to propellers.

INSTRUCTIONAL TESTS IN AERONAUTICS, by Albert J. Rosenberg. World Book Co., Yonkers-on-Hudson, N. Y. 92 pages, photographs, charts, key.

This booklet covers in considerable detail, the tests offered in CAA private pilot examinations. Questions are to be answered in the book then checked by an accompanying supplemental key. The tests, designed primarily for teaching purposes, "may be used satisfactorily in any course in elementary aeronautics, regardless of the text used."

INTO THE AIR AGE, by N. L. Engelhardt, Jr. Air-Age Education Research, N. Y. 25c.

Instructional booklet aiming to give an over-all picture of the flying age and the forces shaping its future outlines. Directed primarily at teachers for use as a source book in preparing courses on the subject.

THEN THERE WAS ONE by Eugene Burns. Harcourt, Brace & Co., N. Y. 212 pages, photographs. $2.50.

Of the seven first-line U. S. carriers when war began, four were sunk in the first year of war, the fifth saw action in non-Pacific waters—and the sixth was out of action at the decisive moment. "Then there was one"—the "Enterprise." This is its story, from Pearl Harbor on through every major action, but one.

MODERN WOOD ADHESIVES, by T. D. Perry. Pitman Publishing Corp., N. Y. 208 pages, illustrations, index. $3.

Handbook of modern wood adhesives in relation to construction and engineering projects in wood. Various types of glues are described and their properties analyzed. Other phases covered are methods of comparing glues; glue mixing and spreading equipment; pressure; adhesion; re-driers; and impregnation and testing, each accorded a chapter.

LONG-RANGE FLIGHT, by Colin Hugh McIntosh. McGraw-Hill Book Co., N. Y. 177 pages, diagrams, flight plans, and graphs. $2.50.

A study of the essential techniques for aircraft operation in long distance flights. This book details the fundamentals that must be understood in order to make use of the charts used by airline operators, also considers long-range flight thought and practice and explains methods of cruising control and preflight planning. Also covered are the principles of efficient engine operation and controlled flight through the use of the "howgozit" chart.

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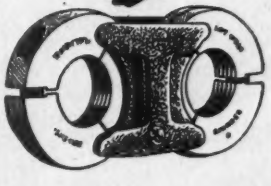

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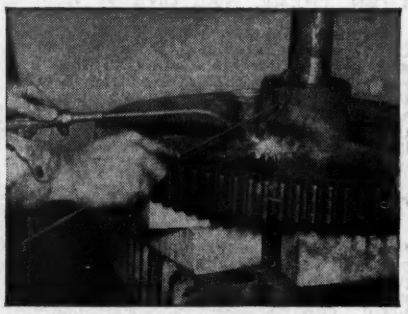

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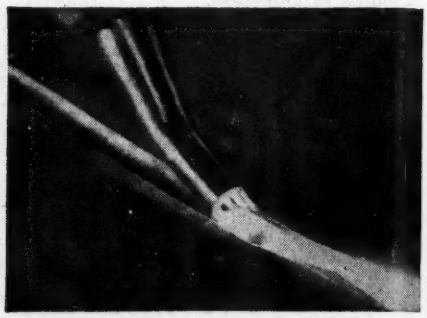
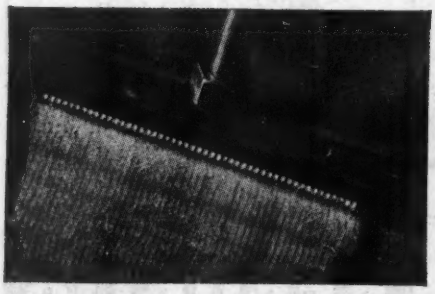
Hand-Cutting

Flame-cutting with manually operated blowpipes is useful for cutting pipe in the fabrication of piping systems. Hand-cutting also is used to cut structural steel in construction or alteration work—to reclaim old pipe—and to cut scrap to length.



Gouging

With Oxweld hand-cutting blowpipes equipped with gouging nozzles, surface metal—such as faulty or temporary welds—can be removed quickly leaving a groove, without need of grinding or chipping, and without harm to the adjacent areas.



Flame-Priming

This process removes loose scale, rust, and surface moisture from steel prior to painting—making paint go on faster, bond tighter, and last longer.

Heating

Heating for bending, straightening, and forming operations is facilitated by the oxy-acetylene flame. Shown here, a pipe is being wrinkle-bent.

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